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A YACHT VOYAGE.

Letters from High Latitudes:

BEING SOME ACCOUNT OF A VOYAGE, IN 1856,
IN THE SCHOONER YACHT "FOAM,"

TO

ICELAND, JAN MAYEN, AND SPITZBERGEN.

BY LORD DUFFERIN

GOVERNOR GENERAL OF THE DOMINION OF CANADA.

NEW YORK:
JOHN W. LOVELL CO., PUBLISHERS,
14 AND 16 VESEY STREET.

"But since it pleased a vanished eye,
I go to plant it on his tomb,
That if it can, it there may bloom,
Or dying—there at least may die."

"He,
To whom a thousand memories call,
Not being less, but more than all
The gentleness he seemed to be,

So wore his outward best, and joined
Each office of the social hour
To noble manners, as the flower
And native growth of noble mind."

In Memoriam.

TO

"THAT TRUE NORTH,"

I DEDICATE

THIS EDITION.

"Witness, too, the silent cry,
The prayer of many a race, and creed, and clime,
Thunderless lightnings striking under sea
From sunset to sunrise of all thy realm,
And that true North."

PREFACE TO THIRD EDITION.

THAT an Universal Language would infinitely multiply the moral and material forces of mankind, is an idea as old as the story of Babel; for it is evident that with such a medium, those waves of thought and conviction, upon whose rapid and ubiquitous propagation depend the progress of our species, would permeate the world with the instantaneous energy of an electric shock, communicating irresistible intensity to all human effort. But is not the punishment pronounced on man's primeval presumption, in the course of reversal? Whatever may be the future fate of the kingdoms, states, and empires founded by the British race, the edict has already gone forth which constitutes our Mother tongue the common language of the chief portion of the earth. From the Arctic Circle to the Gulf of Mexico, along the Western, Southern, and Eastern seaboards of Africa, throughout the peninsula of India, in the ports of China and Japan, amongst the islands of the Pacific Archipelago, and on the Australian continent, the English language already reigns supreme. In another fifty years, the English-speaking population of North America alone will number more than one hundred million souls, whose merchant fleets will whiten the two adjacent oceans, while those of their Australian brethren crowd all the Southern seas. What may not be expected from the exertions of such a civilization, itself the heir of all the ages,—thus unified by the possession of a common language, a common literature, analogous political institutions, the ties of kinsmanship, and a traditional affection!

But it is to the writer of English books that such a prospect is most exhilarting. An author's public is as the breath of his nostrils; his fame is fed by numbers, and the increment of mankind, ensures his immortality. As he glances down the vista of futurity he feels like the actor watching through a hole in a curtain the grateful overflow of a benefit audience along the boxes, pit, and stalls, into the waste places and ultimate recesses of his theatre. It is true the fulness of this joy belongs only to the leading performers; but even the walking gentleman—and to no higher analogy does the present writer pretend—feels a humble pride in the triumphs thus preparing for his more illustrious colleagues, nay, may find consolation in the thought that his own part, however insignificant, is not to be played before empty benches. Though he receive or deserve but scant attention from the audience as a whole, the scattered crumbs of approbation which may fall from amid an infinitude of spectators, will furnish forth, he trusts, what in the sum may prove sufficient material for a very respectable reputation.

It is in some such kindred hope that the author now watches his little book being introduced at the instance of its present publishers to the notice of the inhabitants of the United States. It has already received in England the modest share of patronage to which it was entitled. In Canada other causes have secured for it more attention than it could have claimed on its own merits. If it should be fortunate enough to attract the favor or amuse the lighter hours of his Republican neighbors, his ambition will be more than satisfied; for not only will he feel that his work has been permanently domiciled amid the expanding literature of the American continent, but that he has also contributed, however infinitesimally, to the pleasure of those from so many of whose countrymen he has received both in his public and private capacity unusual marks of courtesy and kindness.

PREFACE ESPECIALLY WRITTEN FOR THE CANADIAN EDITION.

A CYNIC has suggested that after a certain interval the return to life of our dearest relative might often occasion as much perplexity as pleasure.

However harshly this sentiment may grate on the ears of Constancy, I confess to a kindred feeling of embarrassment in being suddenly confronted, after so many years, with the alien self that reappears in the following pages; but I am told that the friendly community with which I am now connected, and with whose fortunes my own are temporarily interwoven, may be disposed to take an interest in the youthful yachting experiences of their present Governor General.

But for this I should never have had the hardihood to appear as an author before the public of this Continent, whose geographical position and fiscal arrangements enable its inhabitants to skim the cream from the literature of Europe, without troubling themselves either with its sedimentary deposits, or the irritating restrictions of its copyrights. Once indeed through the "enterprise" of a transatlantic Editor, whose nationality shall be nameless, a mutilated issue of these "Letters" obtained an ephemeral publicity in a provincial serial, but in spite of my spirited impresario having prefaced his piracy by the assertion that "he had commissioned a British Lord at a handsome salary" to discover the North Pole" and to furnish his Magazine with "an account of his adventures," confirmed as it was by such a transfiguration of the dates, tenses, and superscriptions in my narrative as might best color this ingenious fiction—the speculation must have proved a financial failure, as no per centage on his profits has hitherto reached my hands.

Notwithstanding this discouraging experience, I am still in hopes that the Canadian reader, apart from any personal interest with which he may regard the author, will not grudge an occasional half-hour to a description of those out-land countries that share with his Dominion the Aurora's ruby affluence, and are wrapped by winter in the same silver mantle as his own; whose early mariners—500 years before Columbus—swept through the gulfs of his St. Lawrence, and struck the headlands of his Acadie; and whose modern inhabitants, in the simplicity of their lives, in the nobleness of their courtesy, in the freedom of their political institutions, and in their masculine energy exemplify and prefigure within their lesser limits the qualities, virtues, and attainments proper to a great Northern people.

And here I should be disposed to end my brief apology for this Edition, were it not that I am tempted to seize the opportunity of answering a question that has been frequently put to me—"What has become of Wilson?"

This kind and faithful servant remained with me for many years after my return from the North, environed by something of an heroic halo in the eyes of the ladies of his acquaintance, and of the public whom he frequented. He subsequently accompanied me on an eighteen months' cruise to the Mediterranean, as well as on my visit to Syria as British Commissioner, but neither the sunshine of the South nor the glitter of the particolored East, mercurialized the melancholy of his temperament. In the congenial atmosphere of the graveyards of Egypt he displayed indeed a transient sprightliness, which the occasional exhumation of a mummy, and such traffic with the dead and their appurtenances as my excavations at Thebes afforded him, stimulated into spasms of hilarity.

Of the Pyramids he was disposed to think but lightly, until informed that they had served for sepulchres; but on quitting the heights of Gizeh I observed that he had selected two skulls as the appropriate memorials of his visit. With his brows bound in the folds of a yellow turban, a striped Arab mantle enveloping his person, and seated on a donkey, these fleshless countenances grinning from under either arm,—his own, the least jovial of the three,—he presented, I confess, something of a weird and ghoul-like appearance as, wending round the ransacked tombs of the Pharaohs, we passed to our boats through the purple haze of evening.

He continued to the end to solemnize his announcements with phrases of dolorous import. One day at Thebes I was lying in my berth prostrate with a feverish attack, my nerves in that impressionable state peculiar to sickness in a tropical climate; suddenly Wilson enters the cabin and proclaims in his hollow tones, "If you please, my Lord, the *Corpse* is come aboard!" by which dignified but depressing title he was pleased to designate a mummy which my people had just brought down from a rock-temple I had recently discovered.

His bedside visits, however, were not always so innocuous. On our arrival at Beirût some months afterwards, we found a traveller at the hotel stricken with Syrian fever—a disease which seldom pardons. The patient's life hung by a thread. The doctors had enjoined the most absolute quiet, and every inmate of the house passed his door breathless and on tiptoe. One kind lady, who had constituted herself his nurse, was allowed to visit him. But on an unlucky Sunday afternoon she was absent for a brief half hour at Church.

Forthwith Wilson stole upon his victim, and gliding into a chair at the bed-head, whispered forth at intervals these sentences of dole: "Well, sir! you do look bad!" "Syrian fever, I understand, sir?" "Ah! they say people don't recover from Syrian fever." "I am Wilson, sir." "THE Wilson!" with which ghostlike revelation of his identity he concluded his dismal Avatar, the particulars of which the sick man happily survived to relate.

I could multiply these paragraphs by the relation of a hundred similar traits of my poor follower's saturnine humor. It would be more difficult to give an adequate idea of his kindness and affectionate serviceableness, his resolution in danger, his versatility of resource, and unassailable integrity; only those who have travelled much in wild countries can understand what an infinite enhancement of one's pleasure, comfort and security, is born of such faithful comradeship. If every now and then I have endeavored to enliven my story with glimpses of the share my poor servant took in our daily life, the reader will feel that a loving hand has guided the pencil. To this day I never prepare for a journey without a sigh of regret for my lost travelling companion.

Some time after our return to England, Wilson's health became affected by an obscure disease, which subsequently developed very distressing symptoms, and after much suffering, borne with great patience, he died in the Hospital for incurables at Wimbledon.

OTTAWA, ONT., 1873.

DRAMATIS PERSONÆ.

SIGURDR, *Son of* JONAS, *Icelander; Law Student.*

CHARLES E. FITZGERALD, *Surgeon; Photographer; Botanist.*

LORD DUFFERIN, *Navigator; Sagaman; Artist.*

WILLIAM WILSON, *Valet; Gardener; Cape Colonist.*

ALBERT GRANT, *Steward; Watchmaker; Bird-stuffer.*

JOHN BEVIS, *First Cook; afterwards Ducrow.*

WILLIAM WEBSTER, *Second Cook; Carpenter; late of Her Majesty's Foot Guards; afterwards Maid Marian.*

EBENEZER WYSE, *Master; Californian Gold-digger.*

WILLIAM LEVERETT, *Mate.*

WILLIAM TAYLOR, *Butcher.*

CHARLES PARNE, THOMAS SCARLETT, THOMAS PILCHER, HENRY LEVERETT, JOHN LOCK,	*Seamen.*

WILLIAM WYNHALL, *Ship-boy.*

Voice of a French Captain.

A German Gnat-catcher.

An early Village Cock.

A Goat.

An Icelandic Fox.

A White Bear.

Ladies and Cavaliers of the ICELANDIC, NORSE, LAPPISH, *and* FRENCH *tongues,*

SCENE.—*Sometimes on board the* "FOAM," *sometimes in* ICELAND, SPITZBERGEN, *and* NORWAY.

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LETTERS

FROM HIGH LATITUDES.

LETTER I.

PROTESILAUS STUMBLES ON THE THRESHOLD.

GLASGOW, Monday, June 2, 1856.

Our start has not been prosperous. Yesterday evening, on passing Carlisle, a telegraphic message was put into my hand, announcing the fact of the "*Foam*" having been obliged to put into Holyhead, in consequence of the sudden illness of my Master. As the success of our expedition entirely depends on our getting off before the season is further advanced, you can understand how disagreeable it is to have received this check at its very outset. As yet, of course, I know nothing of the nature of the illness with which he has been seized. However, I have ordered the schooner to proceed at once to Oban, and I have sent back the Doctor to Holyhead to overhaul the sick man. It is rather early in the day for him to enter upon the exercise of his functions.

LETTER II.

THE ICELANDER—A MODERN SIR PATRICK SPENS.

GREENOCK, Tuesday, June 3, 1856.

I found the Icelander awaiting my arrival here,—pacing up and down the coffee-room like a Polar bear.

At first he was a little shy, and, not having yet had much opportunity of practising his English, it was some time before I could set him perfectly at his ease. He has something so frank and honest in his face and bearing, that I am certain he will turn out a pleasant companion. There being no hatred so intense as that which you feel towards a disagreeable shipmate, this assurance has relieved me of a great anxiety, and I already feel I shall hereafter reckon Sigurdr (pronounced Segurthur), the son of Jonas, among the number of my best friends.

As most educated English people firmly believe the Icelanders to be a "Squawmuck," blubber-eating, seal-skin-clad race, I think it right to tell you that Sigurdr is apparelled in good broadcloth, and all the inconveniences of civilization, his costume culminating in the orthodox chimney-pot of the nineteenth century. He is about twenty-seven, very intelligent-looking, and—all women would think—lovely to behold. A high forehead, straight, delicate features, dark blue eyes, auburn hair and beard, and the complexion of—Lady S——d! His early life was passed in Iceland; but he is now residing at Copenhagen as a law student. Through the introduction of a mutual friend, he has been induced to come with me, and do us the honors of his native land.

> "O whar will I get a skeely skipper,
> To sail this gude ship o' mine?"

Such, alas! has been the burden of my song for these last four-and-twenty hours, as I have sat in the Tontine Tower, drinking the bad port wine; for, after spending a fortune in telegraphic messages to Holyhead, it has been decided that B—— cannot come on, and I have been forced to rig up a Glasgow merchant skipper into a jury sailing-master.

Any such arrangement is, at the best, unsatisfactory; but to abandon the cruise is the only alternative. However, considering I had but a few hours to look about me, I have been more fortunate than might have been expected. I have had the luck to stumble on a young fellow, very highly recommended by the Captain of the Port. He returned just a fortnight ago from a trip to Australia, and, having since married a wife, is naturally anxious not to lose this opportunity of going to sea again for a few months.

I start to-morrow for Oban, *viâ* Inverary, which I wish to show to my Icelander. At Oban I join the schooner, and proceed to Stornaway, in the Hebrides; whither the undomestic Mr. Ebenezer Wyse (a descendant, probably, of some Westland Covenanter) is to follow me by the steamer.

LETTER III.

LOCH GOIL—THE SAGA OF CLAN CAMPBELL.

OBAN, June 5, 1856

I have seldom enjoyed anything so much as our journey yesterday. Getting clear at last of the smells, smoke, noise and squalor of Greenock, to plunge into the very heart of the Highland hills, robed as they were in the sunshine of a beautiful summer day, was enough to make one beside oneself with delight; and the Icelander enjoyed it as much as I did. Having crossed the Clyde, alive with innumerable vessels, its waves dancing and sparkling in the sunlight, we suddenly shot into the still and solemn Loch Goil, whose waters, dark with mountain shadows, seemed almost to belong to a different element from that of the yellow, rushing, ship-laden river we had left. In fact, in the space of ten minutes, we had got into another world, centuries remote from the steaming, weaving, delving Britain, south of Clyde.

After a sail of about three hours, we reached the head of the loch, and then took coach along the worst mountain road in Europe, towards the country of the world-invading Campbells. A steady pull of three hours more, up a wild bare glen, brought us to the top of the mica-slate ridge which pens up Loch Fyne, on its western side, and disclosed what I have always thought the loveliest scene in Scotland.

Far below at our feet, and stretching away on either land among the mountains, lay the blue waters of the lake.

On its other side, encompassed by a level belt of pasture-land and corn-fields, the white little town of Inverary glittered like a gem on the sea-shore ; while to the right, amid lawns and gardens, and gleaming banks of wood, that hung down into the water, rose the dark towers of the Castle ; the whole environed by an amphitheatre of tumbled porphyry hills, beyond whose fir-crowned crags rose the bare blue mountain-tops of Lorn.

It was a perfect picture of peace and seclusion, and I confess I had great pride in being able to show my companion so fair a specimen of one of our lordly island homes —the birthplace of a race of nobles whose names sparkle down the page of their country's history as conspicuously as the golden letters in an illuminated missal.

While descending towards the strand, I tried to amuse Sigurdr with a sketch of the fortunes of the great house of Argyll.

I told him how in ancient days three warriors came from Green Ierne, to dwell in the wild glens of Cowal and Lochow,—how one of them, the swart Breachdan, all for the love of blue-eyed Eila, swam the Gulf, once with a clew of thread, then with a hempen rope, last with an iron chain ; but this time, alas ! the returning tide sucks down the over-tasked hero into its swirling vortex ; how Diarmid O' Duin, *i. e.*, son of "the Brown," slew with his own hand the mighty boar, whose head still scowls over the escutcheon of the Campbells ;—how in later times, while the murdered Duncan's son, afterwards the great Malcolm Canmore, was yet an exile at the court of his Northumbrian uncle, ere Birnam wood had marched to Dunsinane, the first Campbell *i. e.*, Campus-bellus, Beau-champ, a Norman knight and nephew of the Conqueror, having won the hand of the Lady Eva, sole heiress of the race of Diarmid, became master of the lands and lordships of Argyll; how six generations later—each of them notable in their day—the valiant Sir Colin created for his posterity a title prouder than any within a sovereign's power to bestow, which no forfeiture could attaint, no act of parliament recall; for though he cease to be Duke or Earl, the head of the Clan Campbell will still remain Mac Calan More,—and how at last the same Sir Colin fell at the String of Cowal, beneath the sword of that fierce lord, whose grand-daughter was destined to bind the honors of his own heirless house round the coronet of his slain foeman's descendant; how Sir Neill at Bannockburn fought side by side with the Bruce whose sister he had married; how Colin, the first Earl, woed and won the Lady Isabel, sprung from the race of Somerled, Lord of the Isles, thus adding the galleys of Lorn to the blazonry of Argyll;—how the next Earl died at Flodden, and his successor fought not less disastrously at Pinkie;—how Archibald, fifth Earl, whose wife was at supper with the Queen, her half-sister, when Rizzio was murdered, fell on the field of Langside, smitten not by the hand of the enemy, but by the finger of God; how Colin, Earl and boy-General at fifteen, was dragged away by force, with tears in his eyes, from the unhappy skirmish at Glenlivit, where his brave Highlanders were being swept down by the artillery of Huntley and Errol,—destined to regild his spurs in future years on the soil of Spain.

Then I told him of the Great Rebellion, and how, amid the tumult of the next fifty years, the Grim Marquis—Gillespie Grumach, as his squint caused him to be called—Montrose's fatal foe, staked life and fortunes in the deadly game engaged in by the fierce spirits of that generation, and losing, paid the forfeit with his head, as calmly as became a brave and noble gentleman, leaving an example, which his son—already twice rescued from the scaffold, once by a daughter of the ever-gallant house of Lindsay, again a prisoner, and a rebel, because four years too soon to be a patriot—as nobly imitated— ; how, at last, the clouds of misfortune cleared away, and honors clustered where only merit had been before; the martyr's aureole, almost become hereditary, being replaced in the next generation by a ducal coronet, itself to be regilt in its turn with a less sinister lustre by him—

> "The State's whole thunder born to wield,
> And shake alike the senate and the field ;"

who baffled Walpole in the cabinet, and conquered with Marlborough at Ramilies, Oudenarde, and Malplaquet ;—and, last,—how at that present moment, even while we were speaking, the heir to all these noble reminiscences, the young chief of his princely line, had already won, at the age of twenty-nine, by the manly vigor of his intellect and his hereditary independence of character, the confidence of his follow countrymen, and a seat at the council board of his sovereign.

Having thus duly indoctrinated Sigurdr with the Sagas of the family, as soon as we had crossed the lake I took him up to the Castle, and acted cicerone to its pictures and heirlooms,—the gleaming stands of muskets, whose fire wrought such fatal ruin at Culloden ;—the portrait of the beautiful Irish girl, twice a Duchess, whom the cunning artist has painted with a sunflower that turns *from* the sun to look at her ;—Gillespie Grumach himself, as grim and sinister-looking as in life; the trumpets to carry the voice from the hall door to Dunnaquaich ;—the fair beech avenues, planted by the old Marquis, now looking with their smooth grey boles, and overhanging branches, like the cloisters of an abbey ;—the vale of Esechasan, to which, on the evening before his execution, the Earl wrote such touching verses ; the quaint old kitchen-garden ; the ruins of the ancient Castle, where worthy Major Dalgetty is said to have passed such uncomfortable moments ; the

Celtic cross from lone Iona; all and everything I showed off with as much pride and pleasure, I think, as if they had been my own possessions; and the more so as the Icelander himself evidently sympathized with such Scald-like gossip.

Having thoroughly overrun the woods and lawns of Inverary, we had a game of chess, and went to bed pretty well tired.

The next morning, before breakfast, I went off in a boat to Ardkinglass to see my little cousins; and then returning about twelve, we got a post-chaise, and crossing the boastful Loch Awe in a ferry-boat, reached Oban at nightfall. Here I had the satisfaction of finding the schooner already arrived, and of being joined by the Doctor, just returned from his fruitless expedition to Holyhead.

LETTER IV.

THROUGH THE SOUNDS—STORNAWAY—THE SETTING UP OF THE FIGURE-HEAD—FITZ'S FORAY—OH WEEL MAY THE BOATIE ROW, THAT WINS THE BAIRNS' BREAD—SIR PATRICK SPENS JOINS—UP ANCHOR.

STORNAWAY, Island of Lewis, Hebrides,
June 9, 1856.

We reached these Islands of the West the day before yesterday, after a fine run from Oban.

I had intended taking Staffa and Iona on my way, but it came on so thick with heavy weather from the south-west, that to have landed on either island would have been out of the question. So we bore up under Mull at one in the morning, tore through the Sound at daylight, rounded Ardnamurchan under a double-reefed mainsail at two P. M., and shot into the Sound of Skye the same evening, leaving the hills of Moidart (one of whose "*seven men*" was an ancestor of your own), and the jaws of the hospitable Loch Hourn, reddening in the stormy sunset.

At Kylakin we were obliged to bring up for the night; but getting under weigh again at daylight, we took a fair wind with us along the east coast of Skye, passed Raasa and Rona, and so across the Minch to Stornaway.

Stornaway is a little fishing town with a beautiful harbor, from out of which was sailing, as we entered, a fleet of herring boats, their brown sails gleaming like gold against the dark angry water as they fluttered out to sea, unmindful of the leaden clouds banked up along the west, and all the symptoms of an approaching gale. The next morning it was upon us; but brought up as we were under the lee of a high rock, the tempest tore harmlessly over our heads, and left us at liberty to make the final preparations for departure.

Fitz, whose talents for discerning where the vegetables, fowls, and pretty ladies of a place were to be found, I had already had occasion to admire, went ashore to forage; while I remained on board to superintend the fixing of our sacred figure head—executed in bronze by Marochetti—and brought along with me by rail, still warm from the furnace.

For the performance of this solemnity I luckily possessed a functionary equal to the occasion, in the shape of the second cook. Originally a guardsman, he had beaten his sword into a chisel, and become carpenter; subsequently conceiving a passion for the sea, he turned his attention to the mysteries of the kitchen, and now sails with me in the alternate exercise of his two last professions. This individual, thus happily combining the chivalry inherent in the profession of arms with the skill of the craftsman and the refinement of the artist—to whose person, moreover, a paper cap, white vestments, and the sacrificial knife at his girdle, gave something of a sacerdotal character—I did not consider unfit to raise the ship's guardian image to its appointed place; and after two hours' reverential handiwork, I had the satisfaction of seeing the well-known lovely face, with its golden hair, and smile that might charm all malice from the elements, beaming like a happy omen above our bows.

Shortly afterwards Fitz came alongside, after a most successful foray among the fish-wives. He was sitting in the stern-sheets, up to his knees in vegetables, with seven elderly hens beside him, and a dissipated looking cock under his arm, with regard to whose qualifications its late proprietor had volunteered the most satisfactory assurances. I am also bound to mention, that protruding from his coat-pocket were certain sheets of music, with the name of "Alice Louisa," written therein in a remarkably pretty hand, which led me to believe that the Doctor had not entirely confined his energies to the acquisition of hens and vegetables. The rest of the day was spent in packing away our newly-purchased stores, and making the ship as tidy as circumstances would admit. I am afraid, however, many a smart yachtsman would have been scandalized at our decks, lumbered up with hen-coops, sacks of coal, and other necessaries, which, like the Queen of Spain's legs, not only ought never to be seen, but must not be supposed even to exist, on board a tip-top craft.

By the evening, the gale, which had been blowing all day, had increased to a perfect hurricane. At nine o'clock we let go a second anchor; and I confess, as we sat comfortably round the fire in the bright cheerful little cabin, and listened to the wind whistling and shrieking through the cordage, that none of us were sorry to find ourselves in port on such a night, instead of tossing on the wild Atlantic—though we little knew that even then the destroying angel was busy with the fleet of fishing boats which had put to sea so gallantly on the evening of our arrival. By morning the neck of the gale was broken, and the sun shone brightly on the white rollers as they chased each other to the shore; but a Queen's ship was steaming into the bay, with sad news of ruin out to seaward,—towing behind her, boats, water-logged, or bottom upwards,—while a silent crowd of women on the quay were waiting to learn on what homes among them the bolt had fallen.

About twelve o'clock the Glasgow packet came in, and a few minutes afterwards I had the honor of receiving on my quarter-deck a gentleman who seemed a cross between the German student and the swell commercial gent. On his head he wore a queer kind of smoking-cap, with the peak cocked over his left ear; then came a green shooting jacket, and flashy silk tartan waistcoat, set off by a gold chain, hung about in innumerable festoons,—while light trousers and knotty Wellington boots completed his costume, and made the wearer look as little like a seaman as need be. It appeared, nevertheless, that the individual in question was Mr. Ebenezer Wyse, my new sailing-master; so I accepted Captain C.'s strong recommendation as a set-off against the silk tartan; explained to the new comer the position he was to occupy on board, and gave orders for sailing in an hour. The multitudinous chain, moreover, so lavishly displayed, turned out to be an ornament of which Mr. Wyse might well be proud; and the following history of its acquisition reconciled me more than anything else to my Master's unnautical appearance.

Some time ago there was a great demand in Australia for small river steamers, which certain Scotch companies undertook to supply. The difficulty, however, was to get such fragile tea-kettles across the ocean; five started one after another in murderous succession, and each came to grief before it got half way to the equator; the sixth alone remained with which to try a last experiment. Should she arrive, her price would more than compensate the pecuniary loss already sustained, though it could not bring to life the hands sacrificed in the mad speculation; by this time, however, even the proverbial recklessness of the seamen of the port was daunted, and the hearts of two crews had already failed them at the last moment of starting, when my friend of the chain volunteered to take the command. At the outset of his voyage everything went well; a fair wind (her machinery was stowed away, and she sailed under canvas) carried the little craft in an incredibly short time a thousand miles to the southward of the Cape, when one day, as she was running before the gale, the man at the wheel—startled at a sea which he thought was going to poop her—let go the helm; the vessel broached to, and tons of water tumbled in on the top of the deck. As soon as the confusion of the moment had subsided, it became evident that the shock had broken some of the iron plates, and that the ship was in a fair way of foundering. So frightened were the crew, that, after consultation with each other, they determined to take to the boats, and all hands came aft, to know whether there was anything the skipper would wish to carry off with him. Comprehending the madness of attempting to reach land in open boats at the distance of a thousand miles from any shore, Wyse pretended to go into the cabin to get his compass, chronometer, etc., but returning immediately with a revolver in each hand, swore he would shoot the first man who attempted to touch the boats. This timely exhibition of spirit saved their lives: soon after the weather moderated; by undergirding the ship with chains, St. Paul fashion, the leaks were partially stopped, the steamer reached her destination, and was sold for 7,000*l*, a few days after her arrival. In token of their gratitude for the good service he had done them, the company presented Mr. Wyse on his return with a gold watch, and the chain he wears so gloriously outside the silk tartan waistcoat.

And now, good-bye. I hear the click-click of the chain as they heave the anchor; I am rather tired and exhausted with all the worry of the last two months, and shall be heartily glad to get to sea, where fresh air will set me up again, I hope, in a few days. My next letter will be from Iceland; and, please God, before I see English land again, I hope to have many a story to tell you of the islands that are washed by the chill waters of the Arctic Sea.

LETTER V.

THE NORTH ATLANTIC—SPANISH WAVES—OUR CABIN IN A GALE—SEA-SICKNESS FROM A SCIENTIFIC POINT OF VIEW —WILSON—A PASSENGER COMMITS SUICIDE—FIRST SIGHT OF ICELAND—FLOKI OF THE RAVENS—THE NORSE MAYFLOWER—FAXA FIORD—WE LAND IN THULE.

REYKJAVIK, ICELAND, June 21, 1855.

WE have landed in Thule! When, in parting, you moaned so at the thought of not being able to hear of our safe arrival, I knew there would be an opportunity of writing to you almost immediately after reaching Iceland; but I said nothing about it at the time, lest something should delay this letter, and you be left to imagine all kinds of doleful reasons for its non-appearance. We anchored in Reykjavik harbour this afternoon (Saturday). H. M. S. "*Coquette*" sails for England on Monday; so that within a week you will get this.

For the last ten days we have been leading the life of the "Flying Dutchman.!' Never do I remember to have had such a dusting: foul winds, gales, and calms—or rather breathing spaces, which the gale took occasionally to muster up fresh energies for a blow—with a heavy head sea, that prevented our sailing even when we got a slant. On the afternoon of the day we quitted Stornaway, I got a notion how it was going to be; the sun went angrily down behind a bank of solid grey cloud, and by the time we were up with the Butt of Lewis, the whole sky was in tatters, and the mercury nowhere, with a heavy swell from the north-west.

As, two years before, I had spent a week in trying to beat through the Roost of Sumburgh under double-reefed try sails, I was at home in the weather; and guessing we were in for it, sent down the topmasts, stowed the boats on board, handed the foresail, rove the ridge-ropes, and reefed all down. By midnight it blew a gale, which continued without intermission until the day we sighted Iceland; sometimes increasing to a hurricane, but broken now and then by sudden lulls, which used to leave us for a couple of hours at a time tumbling about on the top of the great Atlantic rollers—or Spanish waves, as they are called—until I thought the ship would roll the masts out of her. Why they should be called Spanish waves, no one seems to know; but I had always heard the seas were heavier here than in any other part of the world, and certainly they did not belie their character. The little ship behaved beautifully, and many a vessel twice her size would have been less comfortable. Indeed, few people can have any notion of the cosiness of a yacht's cabin under such circumstances. After having remained for several hours on deck, in the presence of the tempest,—peering through the darkness at those black liquid walls of water, mounting above you in ceaseless agitation, or tumbling over in cataracts of gleaming foam,—the wind roaring through the rigging,—timbers creaking as if the ship would break its heart,—the spray and rain beating in your face,—everything around in tumult, suddenly to descend into the quiet of a snug, well-lighted little cabin, with the firelight dancing on the white rosebud chintz, the well-furnished book-shelves, and all the innumerable nick-nacks that decorate its walls,—little Edith's portrait looking so serene,—everything about you as bright and fresh as a lady's boudoir in May Fair,—the certainty of being a good three hundred miles from any troublesome shore,—all combine to inspire a feeling of comfort and security difficult to describe.

These pleasures, indeed, for the first days of our voyage, the Icelander had pretty much to himself. I was laid up with a severe bout of illness I had long felt coming on, and Fitz was sea-sick. I must say, however, I never saw any one behave with more pluck and resolution; and when we return, the first thing you do must be to thank him for his kindness to me on that occasion. Though himself almost prostrate, he looked after me as indefatigably as if he had already found his sea legs; and, sitting down on the cabin floor, with a basin on one side of him, and a pestle and mortar on the other, used to manufacture my pills, between the paroxysms of his malady, with a decorous pertinacity that could not be too much admired.

Strangely enough, too, his state of unhappiness lasted a few days longer than the eight-and-forty hours which are generally sufficient to set people on their feet again. I tried to console him by representing what an occasion it was for observing the phenomena of sea-sickness from a scientific point of view; and I must say he set to work most conscientiously to discover some remedy. Brandy, prussic acid, opium, champagne, ginger, mutton-chops, and tumblers of salt-water, were successively exhibited; but, I regret to say, after a few minutes, each in turn *re*-exhibited itself with monotonous punctuality. Indeed, at one time we thought he would never get over; and the following conversation, which I overheard one morning between him and my servant, did not brighten his hopes of recovery.

This person's name is Wilson, and of all men I ever met he is the most desponding. Whatever is to be done, he is sure to see a lion in the path. Life in his eyes is a perpetual filling of leaky buckets, and a rolling of stones up hill. He is amazed when the bucket holds water, or the stone perches on the summit. He professes but a limited belief in his star,—and success with him is almost a disappointment. His countenance corresponds with the prevailing character of his thoughts, always hopelessly chapfallen; his voice is as of the tomb. He brushes my clothes, lays the cloth, opens the champagne, with the air of one advancing to his execution. I have never seen him smile but once, when he came to report to me that a sea had nearly swept his colleague, the steward, overboard. The son of a gardener at Chiswick, he first took to horticulture; then emigrated as a settler to the Cape, where he acquired his present complexion, which is of a grass-green; and finally served as a steward on board an Australian steam-packet.

Thinking to draw consolation from his professional experiences, I heard Fitz's voice, now very weak, say in a tone of coaxing cheerfulness,—

"Well, Wilson, I suppose this kind of thing does not last long?"

The Voice, as of the tomb.—"I don't know, Sir."

Fitz.—"But you must have often seen passengers sick."

The Voice.—"Often, Sir; *very* sick."

Fitz.—"Well, and on an average, how soon did they recover?"

The Voice.—"Some of them didn't recover, Sir."

Fitz.—"Well, but those that did?"

The Voice.—"I know'd a clergyman and his wife as were ill all the voyage; five months, Sir."

Fitz.—(Quite silent.)

The Voice; now become sepulchral.—They sometimes dies, Sir."

Fitz.—"Ugh!"

Before the end of the voyage, however, this Job's comforter himself fell ill, and the Doctor amply revenged himself by prescribing for him.

Shortly after this, a very melancholy occurrence took place. I had observed for some days past, as we proceeded north, and the nights became shorter, that the cock we shipped at Stornaway had become quite bewildered on the subject of that meteorological phenomenon called the Dawn of Day. In fact, I doubt whether he ever slept for more than five minutes at a stretch, without waking up in a state of nervous agitation, lest it should be cock-crow. At last, when night ceased altogether, his constitution could no longer stand the shock. He crowed once or twice sarcastically, then went melancholy mad: finally, taking a calenture, he cackled lowly (probably of green fields), and leaping overboard, drowned himself. The mysterious manner in which every day a fresh member of his harem used to disappear, may also have preyed upon his spirits.

At last, on the morning of the eighth day, we began to look out for land. The weather had greatly improved during the night; and, for the first time since leaving the Hebrides, the sun had got the better of the clouds, and driven them in confusion before his face. The sea, losing its dead leaden color, had become quite crisp and burnished, darkling into a deep sapphire blue against the horizon; beyond which, at about nine o'clock, there suddenly shot up towards the zenith, a pale, gold aureole, such as precedes the appearance of the good fairy at a pantomime farce; then, gradually lifting its huge back above the water, rose a silver pyramid of snow, which I knew must be the cone of an ice mountain, miles away in the interior of the island. From the moment we got hold of the land, our cruise, as you may suppose, doubled in interest. Unfortunately, however the fair morning did not keep its promise; about one o'clock, the glittering mountain vanished in mist; the sky again became like an inverted pewter cup, and we had to return for two more days to our old practice of threshing to windward. So provoked was I at this relapse of the weather, that, perceiving a whale blowing *convenient*, I could not help suggesting to Sigurdr, son of Jonas, that it was an occasion for observing the traditions of his family; but he excused himself on the plea of their having become obsolete.

The mountain we had seen in the morning was the south east extremity of the Island, the very landfall made by one of its first discoverers.[1] This gentleman not having a compass, (he lived about A. D. 864.) not knowing exactly where the land lay, took on board with him, at starting, three consecrated ravens—as an M. P. would take three well trained pointers to his moor. Having sailed a certain distance he let loose one, which flew back : by this he judged he had not got half-way. Proceeding onwards, he loosed the second, which after circling in the air for some minutes in apparent uncertainty, also made off home, as though it still remained a nice point which were the shorter course towards terra firma. But the third, on obtaining his liberty a few days later, flew forward, and by following the direction in which he had disappeared, Rabna Floki, or Floki of the Ravens, as he came to be called, triumphantly made the land.

The real colonists did not arrive till some years later, for I do not much believe a story they tell of Christian relics, supposed to have been left by Irish fishermen, found on the Westmann islands. A Scandinavian king, named Harold Haarfager (a contemporary of our own King Alfred's) having murdered, burnt, and otherwise exterminated all his brother kings who at that time grew as thick as blackberries in Norway, first consolidated their dominions into one realm, as Edgar did the Heptarchy, and then proceeded to invade the Udal rights of the landholders. Some of them animated with that love of liberty innate in the race of the noble Northmen, rather than submit to his oppressions, determined to look for a new home amid the desolate regions of the icy sea. Freighting a dragon-shaped galley—the "*Mayflower*" of the period—with their wives and children, and all the household monuments that were dear to them, they saw the blue peaks of their dear Norway hills sink down into the sea behind, and manfully set their face towards the west, where—some vague report had whispered—a new land might be found. Arrived in sight of Iceland, the leader of the expedition threw the sacred pillars belonging to his former dwelling into the water, in order that the gods might determine the site of his new home: carried by the tide no one could say in what direction, they were at last discovered, at the end of three years, in a sheltered bay on the west side of the island, and Ingolf[1] came and abode there, and the place became in the course of years Reykjavik, the capital of the country.

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[1] There is in Strabo an account of a voyage made by a citizen of the Greek colony of Marseilles, in the time of Alexander the Great, through the Pillars of Hercules, along the coasts of France and Spain up the English Channel, and so across the North Sea, past an island he calls Thule ; his further progress, he asserted, was hindered by a barrier of a peculiar nature,—neither earth, air, nor sky, but a compound of all three, forming a thick viscid substance which it was impossible to penetrate. Now, whether this same Thule was one of the Shetland islands, and the impassable substance merely a fog,—or Island, and the barricade beyond, a wall of ice, it is impossible to say. Probably Pythias did not get beyond the Shetlands.

Sigurdr having scouted the idea of acting Iphigenia, there was nothing for it but steadily to beat over the remaining hundred and fifty miles, which still separated us from Cape Reikianess. After going for two days hard at it, and sighting the Westmann islands, we ran plump into a fog, and lay to. In a few hours, however, it cleared up into a lovely sunny day, with a warm summer breeze just rippling up the water. Before us lay the long wished-for Cape, with the Meal-sack,—a queer stump of basalt, that flops up out of the sea, fifteen miles south-west of Cape Reikianess, its flat top white with guano, like the mouth of a bag of flour,—five miles on our port bow; and seldom have I remembered a pleasanter four-and-twenty hours than those spent stealing up along the gnarled and crumpled lava flat that forms the western coast of Guldbrand Syssel. Such fishing, shooting, looking through telescopes, and talking of what was to be done on our arrival! Like Antæus, Sigurdr seemed twice the man he was before, at sight of his native land; and the Doctor grew nearly lunatic when after stalking a solent goose asleep on the water, the bird flew away at the moment the schooner hove within shot.

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[1] It was in consequence of a domestic feud that Ingolf himself was forced to emigrate.

The panorama of the bay of Faxa Fiord is magnificent,—with a width of fifty miles from horn to horn, the one running down into a rocky ridge of pumice, the other towering to the height of five thousand feet in a pyramid of eternal snow, while round the intervening semicircle crowd the peaks of a hundred noble mountains. As you approach the shore, you are very much reminded of the west coast of Scotland, except that everything is more *intense*—the atmosphere clearer, the light more vivid, the air more bracing, the hills steeper, loftier, more tormented, as the French say, and more gaunt; while between their base and the sea stretches a dirty greenish slope, patched with houses which themselves, both roof and walls, are of mouldy green, as if some long-since inhabited country had been fished up out of the bottom of the sea.

The effects of light and shadow are the purest I ever saw, the contrasts of color most astonishing,—one square front of a mountain jutting out in a blaze of gold against the flank of another, dyed of the darkest purple, while up against the azure sky beyond, rise peaks of glittering snow and ice. The snow, however, beyond serving as an ornamental fringe to the distance, plays but a very poor part at this season of the year in Iceland. While I write, the thermometer is above 70°. Last night we remained playing at chess on deck till bedtime, without thinking of calling for coats, and my people live in their shirt-sleeves, and—astonishment at the climate.

And now, good-bye. I cannot tell you how I am enjoying myself, body and soul. Already I feel much stronger, and before I return I trust to have laid in a stock of health sufficient to last the family for several generations.

Remember me to——, and tell her she looks too lovely; her face has become of a beautiful bright green—a complexion which her golden crown sets off to the greatest advantage. I wish she could have seen, as we sped across, how passionately the waves of the Atlantic flung their liquid arms about her neck, and how proudly she broke through their embraces, leaving them far behind, moaning and lamenting.

LETTER VI.

REYKJAVIK—LATIN CONVERSATION—I BECOME THE PROPRIETOR OF TWENTY-SIX HORSES—EIDER DUCKS—BESSESTAD—SNORRO STURLESON—THE OLD GREENLAND COLONY—FINLAND—A GENOESE SKIPPER IN THE FIFTEENTH CENTURY—AN ICELANDIC DINNER—SKOAL—AN AFTER-DINNER SPEECH IN LATIN—WINGED RABBITS—DUCROW—START OF THE BAGGAGE-TRAIN.

REYKJAVIK, June 28, 1856.

NOTWITHSTANDING that its site, as I mentioned in my last letter, was determined by auspices not less divine than those of Rome or Athens, Reykjavik is not so fine a city as either, though its public buildings may be thought to be in better repair. In fact, the town consists of a collection of wooden sheds, one story high—rising here and there into a gable end of greater pretensions—built along the lava beach, and flanked at either end by a suburb of turf huts.

On every side of it extends a desolate plain of lava that once must have boiled up red-hot from some distant gateway of hell, and fallen hissing into the sea. No tree or bush relieves the dreariness of the landscape, and the mountains are too distant to serve as a background to the buildings; but before the door of each merchant's house facing the sea, there flies a gay little pennon; and as you walk along the silent streets, whose dust no carriage-wheel has ever desecrated, the rows of flower-pots that peep out of the windows, between curtains of white muslin, at once convince you that notwithstanding their unpretending appearance, within each dwelling reign the elegance and comfort of a woman-tended home.

Thanks to Sigurdr's popularity among his countrymen, by the second day after our arrival we found ourselves no longer in a strange land. With a frank energetic cordiality that quite took one by surprise, the gentlemen of the place at once welcomed us to their firesides, and made us feel that we could give them no greater pleasure than by claiming their hospitality. As, however, it is necessary, if we are to reach Jan Mayen and Spitzbergen this summer, that our stay in Iceland should not be prolonged above a certain date, I determined at once to make preparations for our expedition to the Geysirs and the interior of the country. Our plan at present, after visiting the hot springs, is to return to Reykjavik, and stretch right across the middle of the island to the north coast—scarcely ever visited by strangers. Thence we shall sail straight away to Jan Mayen.

In pursuance of this arrangement, the first thing to do was to buy some horses. Away, accordingly, we went in the gig to the little pier leading up to the merchant's house who had kindly promised Sigurdr to provide them. Everything in the country that is not made of wood is made of lava. The pier was constructed out of huge boulders of lava, the shingle is lava, the sea-sand is pounded lava, the mud on the roads is lava paste, the foundations of the houses are lava blocks, and in dry weather you are blinded with lava dust. Immediately upon landing I was presented to a fine, burly gentleman, who, I was informed, could let me have a steppe-ful of horses if I desired, and a few minutes afterwards I picked myself up in the middle of a Latin oration on the subject of the weather. Having suddenly lost my nominative case, I concluded abruptly with the figure syncope, and a bow, to which my interlocutor politely replied "Ita." Many of the inhabitants speak English, and one or two French, but in default of either of these, your only chance is Latin. At first I found great difficulty in brushing up anything sufficiently conversational, more especially as it was necessary to broaden out the vowels in the high Roman fashion; but a little practice soon made me more fluent, and I got at last to brandish my "Pergratum est," etc., in the face of a new acquaintance, without any misgivings. On this occasion I thought it more prudent to let Sigurdr make the necessary arrangements for our journey, and in a few minutes I had the satisfaction of learning that I had become the proprietor of twenty-six horses, as many bridles and pack-saddles, and three guides.

There being no roads in Iceland, all the traffic of the country is conducted by means of horses, along the bridle-tracks which centuries of travel have worn in the lava plains. As but little hay is to be had, the winter is a season of fasting for all cattle, and it is not until spring is well advanced, and the horses have had time to grow a little fat on the young grass, that you can go a journey. I was a good deal taken aback when the number of my stud was announced to me; but it appears that what with the photographic apparatus, which I am anxious to take, and our tent, it would be impossible to do with fewer animals. The price of each pony is very moderate, and I am told I shall have no difficulty in disposing of all of them, at the conclusion of our expedition.

These preliminaries happily concluded, Mr. J—— invited us into his house, where his wife and daughter—a sunshiny young lady of eighteen—were waiting to receive us. As Latin here was quite useless, we had to entrust Sigurdr with all the pretty things we desired to convey to our entertainers; but it is my firm opinion that that gentleman took a dirty advantage of us, and intercepting the choicest flowers of our eloquence, appropriated them to the advancement of his own interests. However, such expressions of respectful admiration as he suffered to reach their destination were received very graciously, and rewarded with a shower of smiles.

The next few days were spent in making short expeditions in the neighborhood, in preparing our baggage-train, and in paying visits. It would be too long for me to enumerate all the marks of kindness and hospitality I received during this short period. Suffice it to say, that I had the satisfaction of making many very interesting acquaintances, of beholding a great number of very pretty faces, and of partaking of an innumerable quantity of luncheons. In fact, to break bread, or, more correctly speaking, to crack a bottle with the master of the house, is as essential an element of a morning call as the making a bow or shaking hands, and to refuse to take off your glass would be as great an incivility as to decline taking off your hat. From earliest times, as the grand old ballad of the King of Thule tells us, a beaker was considered the fittest token a lady could present to her true-love—

Dem ſterbend ſeine Buhle
Einen goldnen Becher gab.

And in one of the most ancient Eddaic songs it is written, "Drink, Runes, must thou know, if thou wilt maintain thy power over the maiden thou lovest. Thou shalt score them on the drinking-horn, on the back of thy hand, and the word NAUD" (*need*—necessity) "on thy nail." Moreover, when it is remembered that the ladies of the house themselves minister on these occasions, it will be easily understood that all flinching is out of the question. What is a man to do, when a wicked little golden-haired maiden insists on pouring him out a bumper, and dumb show is the only means of remonstrance? Why, of course, if death were in the cup, he must make her a leg, and drain it to the bottom, as I did. In conclusion, I am bound to add that, notwithstanding the bacchanalian character prevailing in these visits, I derived from them much interesting and useful information; and I have invariably found the gentlemen to whom I have been presented persons of education and refinement, combined with a happy, healthy, jovial temperament, that invests their conversation with a peculiar charm.

At this moment people are in a great state of excitement at the expected arrival of H. I. H. Prince Napoleon, and two days ago a large full-rigged ship came in laden with coal for his use. The day after we left Stornaway, we had seen her scudding away before the gale on a due west course, and guessed she was bound for Iceland, and running down the longitude; but as we arrived here four days before her, our course seems to have been a better one. The only other ship here is the French frigate "*Artemise*," Commodore Dumas, by whom I have been treated with the greatest kindness and civility.

On Saturday we went to Vedey, a beautiful little green island where the eider ducks breed, and build nests with the soft under-down plucked from their own bosoms. After the little ones are hatched, and their birthplaces deserted, the nests are gathered, cleaned, and stuffed into pillow-cases, for pretty ladies in Europe to lay their soft, warm cheeks upon, and sleep the sleep of the innocent; while long-legged, broad-shouldered Englishmen protrude from between them at German inns, like the ham from a sandwich, and cannot sleep, however innocent.

The next day, being Sunday, I read prayers on board, and then went for a short time to the cathedral church,—the only stone building in Reykjavik. It is a moderate-sized, unpretending place, capable of holding three or four hundred persons, erected in very ancient times, but lately restored. The Icelanders are of the Lutheran religion; and a Lutheran clergyman, in a black gown, etc., with a ruff round his neck, such as our bishops are painted in about the time of James the First, was preaching a sermon. It was the first time I had heard Icelandic spoken continuously, and it struck me as a singularly sweet caressing language, although I disliked the particular cadence, amounting almost to a chant, with which each sentence ended.

As in every church where prayers have been offered up since the world began, the majority of the congregation were women, some few dressed in bonnets, and the rest in the national black silk skull-cap, set jauntily on one side of the head, with a long black tassel hanging down to the shoulder, or else in a quaint mitre of white linen, of which a drawing alone could give you an idea; the remainder of an Icelandic lady's costume, when not superseded by Paris fashions, consists of a black bodice fastened in front with silver clasps, over which is drawn a cloth jacket, ornamented with a multitude of silver buttons; round the neck goes a stiff ruff of velvet, figured with silver lace, and a silver belt, often beautifully chased, binds the long dark wadmal petticoat round the waist. Sometimes the ornaments are of gold instead of silver, and very costly.

Before dismissing his people, the preacher descended from the pulpit, and putting on a splendid cope of crimson velvet (in which some bishop had in ages past been murdered), turned his back to the congregation, and chanted some Latin sentences in good round Roman style. Though still retaining in their ceremonies a few vestiges of the old religion, though altars, candles, pictures, and crucifixes, yet remain in many of their churches, the Icelanders are staunch Protestants, and, by all accounts, the most devout, innocent, pure-hearted people in the world. Crime, theft.

debauchery, cruelty, are unknown amongst them; they have neither prison, gallows, soldiers, nor police; and in the manner of the lives they lead among their secluded valleys, there is something of a patriarchal simplicity, that reminds one of the Old World princes, of whom it has been said, that they were "upright and perfect, eschewing evil, and in their hearts no guile."

The law with regard to marriage, however, is sufficiently peculiar. When, from some unhappy incompatibility of temper, a married couple live so miserably together as to render life insupportable, it is competent for them to apply to the Danish Governor of the island for a divorce. If after the lapse of three years from the date of the application, both are still of the same mind, and equally eager to be free, the divorce is granted, and each is at liberty to marry again.

The next day it had been arranged that we were to take an experimental trip on our new ponies, under the guidance of the learned and jovial Rector of the College. Unfortunately the weather was dull and rainy, but we were determined to enjoy ourselves in spite of everything, and a pleasanter ride I have seldom had. The steed Sigurdr had purchased for me was a long-tailed, hog-maned, shaggy, cow-houghed creature, thirteen hands high, of a bright yellow color, with admirable action, and sure-footed enough to walk downstairs backwards. The Doctor was not less well mounted; in fact, the Icelandic pony is quite a peculiar race, much stronger, faster, and better bred than the Highland shelty, and descended probably from pure-blooded sires that scoured the steppes of Asia, long before Odin and his paladins had peopled the valleys of Scandinavia.

The first few miles of our ride lay across an undulating plain of dolorite, to a farm situated at the head of an inlet of the sea. At a distance, the farm-steading looked like a little oasis of green, amid the grey stony slopes that surrounded it, and on a nearer approach not unlike the vestiges of a Celtic earthwork, with the tumulus of a hero or two in the centre ; but the mounds turned out to be nothing more than the grass roofs of the house and offices, and the banks and dykes but circumvallations round the plot of most carefully cleaned meadow, called the "tùn," which always surrounds every Icelandic farm. This word "tùn" is evidently identical with our own Irish "*townland*," the Cornish "*town*," and the Scotch "*toon*,"—terms which, in their local signification, do not mean a congregation of streets and buildings, but the yard, and spaces of grass immediately adjoining a single house ; just as in German we have "*tzaun*," and in the Dutch "*tuyn*," a garden.

Turning to the right, round the head of a little bay, we passed within forty yards of an enormous eagle, seated on a crag ; but we had no rifle, and all he did was to rise heavily into the air, flap his wings like a barn-door fowl, and plump lazily down twenty yards farther off. Soon after, the district we traversed became more igneous, wrinkled, cracked, and ropy than anything we had yet seen, and another two hours' scamper over such a track as till then I would not have believed horses could have traversed, even at a foot's pace, brought us to the solitary farm-house of Bessestad. Fresh from the neat homesteads of England that we had left sparkling in the bright spring weather, and sheltered by immemorial elms,—the scene before us looked expressibly desolate. In front rose a cluster of weather-beaten wooden buildings, and huts like ice-houses, surrounded by a scanty plot of grass, reclaimed from the craggy plain of broken lava that stretched—the home of ravens and foxes—on either side to the horizon. Beyond, lay a low, black breadth of moorland, intersected by patches of what was neither land nor water, and last, the sullen sea ; while above our heads a wind, saturated with the damps of the Atlantic, went moaning over the landscape. Yet this was Bessestad, the ancient home of Snorro Sturleson!

On dismounting from our horses and entering the house things began to look more cheery; a dear old lady, to whom we were successively presented by the Rector, received us, with the air of a princess, ushered us into her best room, made us sit down on the sofa—the place of honor—and assisted by her niece, a pale, lily-like maiden, named after Jarl Hakon's Thora, proceeded to serve us with hot coffee, rusks, and sweetmeats. At first it used to give me a very disagreeable feeling to be waited upon by the woman-kind of the household, and I was always starting up, and attempting to take the dishes out of their hands, to their infinite surprise; but now I have succeeded in learning to accept their ministrations with the same unembarrassed dignity as my neighbors. In the end, indeed, I have rather got to like it, especially when they are as pretty as Miss Thora. To add, moreover, to our content, it appeared that that young lady spoke a little French; so that we had no longer any need to pay our court by proxy, which many persons besides ourselves have found to be unsatisfactory. Our hostess lives quite alone. Her son, whom I have the pleasure of knowing, is far away, pursuing a career of honor and usefulness at Copenhagen, and it seems quite enough for his mother to know that he is holding his head high among the princes of literature, and the statesmen of Europe, provided only news of his success and advancing reputation shall occasionally reach her across the ocean.

Of the rooms and the interior arrangement of the house, I do not know that I have anything particular to tell you; they seemed to me like those of a good old-fashioned farm-house, the walls wainscoted with deal, and the doors and staircase of the same material. A few prints, a photograph, some book-shelves, one or two little pictures, decorated the parlor, and a neat iron stove, and massive chests of drawers, served to furnish it very completely. But you must not, I fear, take the drawing-room of Bessestad as an average specimen of the comfort of an Icelandic *intérieur*. The greater proportion of the inhabitants of the island live much more rudely. The walls of only the more substantial farmsteads are wainscoted with deal, or even partially screened with drift-wood. In most houses the bare blocks of lava, pointed with moss, are left in all their natural ruggedness. Instead of wood, the rafters are made of the ribs of whales. The same room but too often serves as the dining, sitting, and sleeping place for the whole family; a hole in the roof is the only chimney, and a horse's skull the most luxurious *fauteuil* into which it is possible for them to induct a stranger. The *parquet* is that originally laid down by Nature,—the beds are merely boxes filled with feathers or sea-weed,—and by all accounts the nightly packing is pretty close, and very indiscriminate.

After drinking several cups of coffee, and consuming at least a barrel of rusks, we rose to go, in spite of Miss Thora's intimation that a fresh jorum of coffee was being brewed. The horses were re-saddled; and with an eloquent exchange of bows, curtseys, and kindly smiles, we took leave of our courteous entertainers, and sallied forth into the wind and rain. It was a regular race home, single file, the Rector leading; but as we sped along in silence, amid the unchangeable features of this strange land, I could not help thinking of him whose shrewd observing eye must have rested, six hundred and fifty years ago, on the selfsame crags, and tarns, and distant mountain-tops; perhaps on the very day he rode out in the pride of his wealth, talent, and political influence, to meet his murderers at Reikholt. And mingling with his memory would rise the pale face of Thora,—not the little lady of the coffee and biscuits we had just left, but that other Thora, so tender and true, who turned back King Olaf's hell-hounds from the hiding-place of the great Jarl of Ladé.

In order that you may understand why the forlorn barrack we had just left, and its solitary inmates, should have set me thinking of the men and women "of a thousand summers back," it is necessary I should tell you a little about this same Snorro Sturleson, whose memory so haunted me.

Colonized as Iceland had been,—not, as is generally the case, when a new land is brought into occupation, by the poverty-stricken dregs of a redundant population, nor by a gang of outcasts and ruffians, expelled from the bosom of a society which they contaminated,—but by men who in their own land had been both rich and noble,—with possessions to be taxed, and a spirit too haughty to endure taxation,—already acquainted with whatever of refinement and learning the age they lived in was capable of supplying,—it is not surprising that we should find its inhabitants, even from the first infancy of the republic, endowed with an amount of intellectual energy hardly to be expected in so secluded a community.

Perhaps it was this very seclusion which stimulated into almost miraculous exuberance the mental powers already innate in the people. Undistracted during several successive centuries by the bloody wars, and still more bloody political convulsions, which for too long a period rendered the sword of the warrior so much more important to European society than the pen of the scholar, the Icelandic settlers, devoting the long leisure of their winter nights to intellectual occupations, became the first of any European nation to create for themselves a native literature. Indeed, so much more accustomed did they get to use their heads than their hands, that if an Icelander were injured he often avenged himself, not by cutting the throat of his antagonist, but by ridiculing him in some pasquinade,—sometimes, indeed, he did both; and when the King of Denmark maltreats the crew of an Icelandic vessel shipwrecked on his coast, their indignant countrymen send the barbarous monarch word, that by way of reprisal, they intend making as many lampoons on him as there are promontories in his dominions. Almost all the ancient Scandinavian manuscripts are Icelandic; the negotiations between the Courts of the North were conducted by Icelandic diplomatists; the earliest topographical survey with which we are acquainted was Icelandic; the cosmogony of the Odin religion was formulated, and its doctrinal traditions and ritual reduced to a system, by Icelandic archæologists; and the first historical composition ever written by any European in the vernacular, was the product of Icelandic genius. The title of this important work is "*The Heimskringla*," or *world-circle*,[1] and its author was—Snorro Sturleson! It consists of an account of the reigns of the Norwegian kings from mythic times down to about A. D. 1150, that is to say, a few years before the death of our own Henry II: but detailed by the old Sagaman with so much art and cleverness as almost to combine the dramatic power of Macaulay with Clarendon's delicate delineation of character, and the charming loquacity of Mr. Pepys. His stirring sea-fights, his tender love-stories, and delightful bits of domestic gossip, are really inimitable;—you actually live with the people he brings upon the stage, as intimately as you do with Falstaff, Percy, or Prince Hal; and there is something in the bearing of those old heroic figures who form his *dramatis personæ*, so grand and noble, that it is impossible to read the story of

[1] So called because Heimskringla (world-circle) is the first word in the opening sentence of the manuscript which catches the eye.

their earnest stirring lives without a feeling of almost passionate interest—an effect which no tale frozen up in the monkish Latin of the Saxon annalists has ever produced upon me.

As for Snorro's own life, it was eventful and tragic enough. Unscrupulous, turbulent, greedy of money, he married two heiresses—the one, however, becoming the *colleague*, not the successor of the other. This arrangement naturally led to embarrassment. His wealth created envy, his excessive haughtiness disgusted his sturdy fellow-countrymen. He was suspected of desiring to make the republic an appanage of the Norwegian crown, in the hope of himself becoming viceroy; and at last, on a dark September night, of the year 1241, he was murdered in his house at Reikholt by his three sons-in-law.

The same century which produced the Herodotean work of Sturleson also gave birth to a whole body of miscellaneous Icelandic literature,—though in Britain and elsewhere bookmaking was entirely confined to the monks, and merely consisted in the compilation of a series of bald annals locked up in bad Latin. It is true, Thomas of Ercildoune was a contemporary of Snorro's; but he is known to us more as a magician than as a man of letters; whereas histories, memoirs, romances, biographies, poetry, statistics, novels, calendars, specimens of almost every kind of composition, are to be found even among the meagre relics which have survived the literary decadence that supervened on the extinction of the republic.

It is to these same spirited chroniclers that we are indebted for the preservation of two of the most remarkable facts in the history of the world: the colonization of Greenland by Europeans in the 10th century, and the discovery of America by the Icelanders at the commencement of the 11th.

The story is rather curious.

Shortly after the arrival of the first settlers in Iceland, a mariner of the name of Eric the Red discovers a country away to the west, which, in consequence of its fruitful appearance, he calls Greenland. In the course of a few years the new land has become so thickly inhabited that it is necessary to erect the district into an episcopal see ; and at last, in 1448, we have a brief of Pope Nicolas "granting to his beloved children of Greenland, in consideration of their having erected many sacred buildings and a splendid cathedral,"—a new bishop and a fresh supply of priests. At the commencement, however, of the next century, this colony of Greenland, with its bishops, priests and people, its one hundred and ninety townships, its cathedral, its churches, its monasteries, suddenly fades into oblivion, like the fabric of a dream. The memory of its existence perishes, and the allusions made to it in the old Scandinavian Sagas gradually come to be considered poetical inventions or pious frauds. At last, after a lapse of four hundred years, some Danish missionaries set out to convert the Esquimaux ; and there, far within Davis' Straits, are discovered vestiges of the ancient settlement,—remains of houses, paths, walls, churches, tombstones, and inscriptions.[1]

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[1] On one tombstone there was written in Runic. "Vigdis M. D. Hvilir Her; Glwde Gude Sal Hennar." "Vigdessa rests here; God gladden her soul." But the most interesting of these inscriptions is one discovered, in 1824, in an island in Baffin's Bay, in latitude 72° 55′, as it shows how boldly these Northmen must have penetrated into regions supposed to have been unvisited by man before the voyages of our modern navigators :—"Erling Sighvatson and Biomo Thordarson, and Eindrid Oddson, on Saturday before Ascension-week, raised these marks and cleared ground, 1135." This date of Ascension-week implies that these three men wintered here, which must lead us to imagine that at that time, seven hundred years ago, the climate was less inclement than it is now.

What could have been the calamity which suddenly annihilated this Christian people, it is impossible to say; whether they were massacred by some warlike tribe of natives, or swept off to the last man by the terrible pestilence of 1349, called "The Black Death," or,—most horrible conjecture of all,—beleaguered by vast masses of ice setting down from the Polar Sea along the eastern coast of Greenland, and thus miserably frozen,—we are never likely to know—so utterly did they perish, so mysterious has been their doom.

On the other hand, certain traditions, with regard to the discovery of a vast continent by their forefathers away in the south-west, seems never entirely to have died out of the memory of the Icelanders; and in the month of February, 1477, there arrives at Reykjavik, in a barque belonging to the port of Bristol, a certain long-visaged, grey-eyed Genoese mariner, who was observed to take an amazing interest in hunting up whatever was known on the subject. Whether Columbus—for it was no less a personage than he—really learned anything to confirm him in his noble resolutions, is uncertain; but we have still extant an historical manuscript, written at all events before the year 1395, that is to say, one hundred years prior to Columbus' voyage, which contains a minute account of how a certain person named Lief, while sailing over to Greenland, was driven out of his course by contrary winds, until he found himself off an extensive and unknown coast, which increased in beauty and fertility as he descended south, and how, in consequence of the representation Lief made on his return, successive expeditions were undertaken in the same direction. On two occasions their wives seem to have accompanied the adventurers; of one ship's company the skipper was a lady: while two parties even wintered in the new land, built houses, and prepared to colonize. For some reason how ever, the intention was abandoned; and in process of time these early voyages came to be considered as apocryphal as the Phœnician circumnavigation of Africa in the time of Pharaoh Necho.

It is quite uncertain how low a latitude in America the Northmen ever reached; but from the description given of the scenery, products, and inhabitants,—from the mildness of the weather,—and from the length of the day on the 21st of December,—it is conjectured they could not have descended much farther than Newfoundland, Nova Scotia, or, at most, the coast of Massachusetts.[1]

But to return to more material matters.

Yesterday—no—the day before—in fact I forget the date of the day—I don't believe it had one—all I know is, I have not been in bed since,—we dined at the Governor's;—though dinner is too modest a term to apply to the entertainment.

The invitation was for four o'clock, and at half-past three we pulled ashore in the gig; I, innocent that I was, in a well-fitting white waistcoat.

The Government House, like all the others, is built of wood, on the top of a hillock; the only accession of dignity it can boast being a little bit of mangy kitchen-garden that hangs down in front to the road, like a soiled apron. There was no lock, handle, bell, or knocker to the door, but immediately on our approach, a servant presented himself, and ushered us in to the room where Count Trampe was waiting to welcome us. After having been presented to his wife, we proceeded to shake hands with the other guests, most of whom I already knew; and I was glad to find that at all events in Iceland, people do not consider it necessary to pass the ten minutes which precede the announcement of dinner, as if they had assembled to assist at the opening of their entertainer's will, instead of his oysters. The company consisted of the chief dignitaries of the island, including the Bishop, the Chief Justice, etc., etc., some of them in uniform, and all with holiday faces. As soon as the door was opened, Count Trampe tucked me under his arm—two other gentlemen did the same to my two companions—and we streamed into the dining-room. The table was very prettily arranged with flowers, plate, and a forest of glasses. Fitzgerald and I were placed on either side of our host, the other guests, in due order, beyond. On my left sat the rector, and opposite, next to Fitz, the chief physician of the island. Then began a series of transactions of which I have no distinct recollection; in fact, the events of the next five hours recur to me in as great disarray as reappear the vestiges of a country that has been disfigured by some deluge. If I give you anything like a connected account of what passed, you must thank Sigurdr's more solid temperament; for the Doctor looked quite foolish when I asked him—tried to feel my pulse—could not find it—and then wrote the following prescription, which I believe to be nothing more than an invoice of the number of bottles he himself disposed of.[1]

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[1] There is a certain piece of rock on the Taunton river, in Massachusetts, called the Deighton Stone, on which are to be seen rude configurations, for a long time supposed to be a Runic inscription executed by these Scandinavian voyagers; but there can be now no longer any doubt of this inscription, such as it is, being of Indian execution.

I gather, then, from evidence—internal and otherwise—that the dinner was excellent, and that we were helped

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[1] Copy of Dr. F's prescription:

℞	vin : claret :	iii btls.
	vin : champ :	iv btls.
	vin : sherr ;	½ btl.
	vin : Rheni :	ii btls.
	aqua vitæ	viii gls.

trigint : poc : ægrot : cap : quotid :

C. E. F

Reik : die Martis, Junii 27.

in Benjamite proportions; but as before the soup was finished I was already hard at work hŏb-nobbing with my two neighbors, it is not to be expected I should remember the bill of fare.

With the peculiar manners used in Scandinavian skoal-drinking I was already well acquainted. In the nice conduct of a wine glass I knew that I excelled, and having an hereditary horror of heel-taps, I prepared with a firm heart to respond to the friendly provocations of my host. I only wish you could have seen how his kind face beamed with approval when I chinked my first bumper against his, and having emptied it at a draught, turned it towards him bottom upwards, with the orthodox twist. Soon however, things began to look more serious even than I had expected. I knew well that to refuse a toast, or to half empty your glass, was considered churlish. I had come determined to accept my host's hospitality as cordially as it was offered. I was willing, at a pinch, to *payer de ma personne;* should he not be content with seeing me *at* his table, I was ready, if need were, to remain *under* it! but at the rate we were then going it seemed probable this consummation would take place before the second course: so, after having exchanged a dozen rounds of sherry and champagne with my two neighbors, I pretended not to observe that my glass had been refilled; and like the sea-captain, who, slipping from between his two opponents, left them to blaze away at each other the long night through,—withdrew from the combat. But it would not do; with untasted bumpers, and dejected faces, they politely waited until I should give the signal for a renewal of *host*ilities, as they well deserved to be called. Then there came over me a horrid, wicked feeling. What if I should endeavor to floor the Governor and so literally turn the tables on him! It is true I had lived for five-and-twenty years without touching wine,—but was not I my great-grandfather's great-grandson, and an Irish peer to boot? Were there not traditions, too, on the other side of the house, of casks of claret brought up into the dining-room, the door locked, and the key thrown out of the window? With such antecedents to sustain me I ought to be able to hold my own against the staunchest toper in Iceland! So with a devil glittering in my left eye I winked defiance right and left, and away we went at it again for another five-and-forty minutes. At last their fire slackened: I had partially quelled both the Governor and the Rector, and still survived. It is true I did not feel comfortable; but it was in the neighborhood of my waistcoat, not my head, I suffered. "I am not well but I will not out," I soliloquized, with Lepidus[1]—"*δός μοι τὸ πτερόν*," I would have added, had I dared. Still the neck of the banquet was broken—Fitzgerald's chair was not yet empty,—could we hold out perhaps a quarter of an hour longer, our reputation was established; guess then my horror, when the Icelandic Doctor, shouting his favorite dogma by way of battle cry, "Si trigintis guttis, morbum curare velis, erras," gave the signal for an unexpected onslaught and the twenty guests poured down on me in succession. I really thought I should run away from the house; but the true family blood, I suppose, began to show itself, and with a calmness almost frightful, I received them one by one.

After this began the public toasts.

Although up to this time I had kept a certain portion of my wits about me, the subsequent hours of the entertainment became henceforth developed in a dreamy mystery I can perfectly recall the look of the sheaf of glasses that stood before me, six in number; I could draw the pattern of each; I remember feeling a lazy wonder they should always be full, though I did nothing but empty them,—and at last solved the phenomenon by concluding I had become a kind of Danaid whose punishment, not whose sentence, had been reversed; then suddenly I felt as if I were disembodied,—a distant spectator of my own performances and of the feast at which my person remained seated. The voices of my host, of the Rector, of the Chief Justice, became thin and low, as though they reached me through a whispering tube; and when I rose to speak, it was to an audience in another sphere, and in a language of another state of being: yet, however unintelligible to myself, I must have been in some sort understood, for at the end of each sentence, cheers, faint as the roar of waters on a far-off strand, floated towards me; and if I am to believe a report of the proceedings subsequently shown us, I must have become polyglot in my cups. According to that report it seems the governor threw off (I wonder he did not do something else), with the Queen's health in French: to which I responded in the same language. Then the rector in English, proposed my health,—under the circumstances a cruel mockery,—but to which, ill as I was, I responded very gallantly by drinking to the *beaux yeux* of the Countess. Then somebody else drank success to Great Britain and I see it was followed by really a very learned discourse by Lord D., in honor of the ancient Icelanders; during which he alluded to their discovery of America, and Columbus' visit. Then came a couple of speeches in Icelandic, after which the Bishop, in a magnificent Latin oration of some twenty minutes, a second time, proposes my health to which, utterly at my wits' end, I had the audacity to reply in the same language. As it is fit so great an effort of oratory should not perish, I send you some of its choicest specimens:—

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[1] Antony and Cleopatra.

"Viri illustres," I began, "insolitus ut sum ad publicum loquendum, ego propero respondere ad complimentum quod recte reverendus prelaticus mihi fecit, in proponendo

meam salutem: et supplico vos credere quod multum gratificatus et flattificatus sum honore tam distincto.

"Bibere, viri illustres, res est, quæ in omnibus terris, 'domum venit ad hominum negotia et pectora:[1] (1) requirit haustum longum, haustum fortem, et haustum omnes simul:' (2) ut canit Poeta, 'unum tactum Naturæ totum orben facit consanguineum,' (3) et hominis Natura est—bibere (4).

"Viri illustres, alterum est sentimentum equaliter universale: terra communis super quam septentrionales et meridionales, eâdem enthusiasmâ convenire possunt: est necesse quod id nominarem? Ad pulchrum sexum devotio!

"Amor regit palatium, castra, lucum: (5) Dubito sub quo capite vestram jucundam civitatem numerare debeam. Palatium? non Regem! Castra? non milites! lucum? non ullam arborem habetis! Tamen Cupido vos dominat haud aliter quam alios,—et virginum Islandarum pulchritudo, per omnes regiones cognita est.

"Bibamus salutem earum, et confusionem ad omnes bacularios: speramus quod eæ carœ et benedictæ creaturæ invenient tot maritos quot velint,—quod geminos quottanis habeant, et quod earum filiæ, maternum exemplum sequentes, gentem Islandicam perpetuent in sæcula sæculorum."

The last words mechanically rolled out, in the same

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[1] As the happiness of these quotations seemed to produce a very pleasing effect on my auditors, I subjoin a translation of them for the benefit of the unlearned:—

1. "Comes home to men's business and bosoms."—*Paterfamilias, Times.*

2. "A long pull, a strong pull, and a pull all together."—*Nelson at the Nile.*

3. "One touch of nature makes the whole world kin."—*Jeremy Bentham.*

4. Apothegm by the late Lord Mountcoffeehouse.

5. "Love rules the court, the camp, the grove."—*Venerable Bede.*

"ore rotundo" with which the poor old Dean of Christchurch used to finish his Gloria, etc., in the Cathedral.

Then followed more speeches,—a great chinking of glasses,—a Babel of conversation,—a kind of dance round the table, while we successively gave each alternate hand, as in the last figure of the Lancers,—a hearty embrace from the Governor,—and finally,—silence, daylight, and fresh air, as we stumbled forth into the street.

Now what was to be done? To go to bed was impossible. It was eleven o'clock by our watches, and as bright as noon. Fitz said it was twenty-two o'clock; but by this time he had reached that point of enlargement of the mind, and development of the visual organs, which is expressed by the term "seeing double,"—though he now pretends he was only reckoning time in the Venetian manner. We were in the position of three fast young men about Reykjavik, determined to make a night of it, but without the wherewithal. There were neither knockers to steal, nor watchmen to bonnet. At last we remembered that the apothecary's wife had a conversazione, to which she had kindly invited us; and accordingly, off we went to her house. Here we found a number of French officers, a piano, and a young lady; in consequence of which the drum soon became a ball. Finally, it was proposed we should dance a reel; the second lieutenant of the "*Artemise*" had once seen one when his ship was riding out a gale in the Clyde;—the little lady had frequently studied a picture of the Highland fling on the outside of a copy of Scotch music;—I could dance a jig—the set was complete, all we wanted was music. Luckily the lady of the house knew the song of "Annie Laurie," —played fast it made an excellent reel tune. As you may suppose, all succeeded admirably; we nearly died of laughing, and I only wish Lord Breadalbane had been by to see.

At one in the morning, our *danseuse* retiring to rest, the ball necessarily terminated; but the Governor's dinner still forbidding bed, we determined on a sail in the cutter to some islands about three-quarters of a mile out to sea; and I do not think I shall ever forget the delicious sensation of lying down lazily in the stern-sheets, and listening to the rippling of the water against the bows of the boat, as she glided away towards them. The dreamy, misty landscape, —each headland silently sleeping in the unearthly light,— Snœfell, from whose far-off peaks the midnight sun, though lost to us, had never faded,—the Plutonic crags that stood around, so gaunt and weird,—the quaint fresh life I had been lately leading,—all combined to promise such an existence of novelty and excitement in that strange Arctic region on the threshold of which we were now pausing, that I could not sufficiently congratulate myself on our good fortune. Soon, however, the grating of our keel upon the strand disturbed my reflections, and by the time I had unaccountably stepped up to my knees in the water, I was thoroughly awake, and in a condition to explore the island. It seemed to be about three-quarters of a mile long, not very broad, and a complete rabbit-warren; in fact, I could not walk a dozen yards without tripping up in the numerous burrows by which the ground was honeycombed: at last, on turning a corner, we suddenly came on a dozen rabbits, gravely sitting at the mouths of their holes. They were quite white, without ears, and with scarlet noses. I made several desperate attempts to catch some of these singular animals, but though one or two allowed me to come pretty near, just as I thought my prize was secure, in some unaccountable manner—it made unto itself wings, and literally flew away! Moreover, if my eyesight did not share the peculiar development which affected that of the Doctor's, I should say that these rabbits flew in *pairs*. Red-nosed, winged rabbits! I had never heard or read of the species; and I naturally grew enthusiastic in the chase, hoping to bring home a choice specimen to astonish our English naturalists. With some difficulty we managed to catch one or two, which had run into their holes instead of flying away. They bit and scratched like tiger-cats, and screamed like parrots ; indeed, on a nearer inspection, I am obliged to confess that they assumed the appearance of birds,[1] which may perhaps account for their powers of flight. A slight confusion still remains in my mind as to the real nature of the creatures.

At about nine o'clock we returned to breakfast ; and the rest of the day was spent in taking leave of our friends, and organizing the baggage-train, which was to start at midnight, under the command of the cook. The cavalcade consisted of eighteen horses, but of these only one-half were laden, two animals being told off to each burthen, which is shifted from the back of the one to that of the other every four hours. The pack-saddles were rude, but serviceable articles, with hooks on either side, on which a pair of oblong little chests were slung ; strips of turf being stuffed beneath to prevent the creature's back being galled. Such of our goods as could not be conveniently stowed away in the chests were fitted on to the top, in whatever manner their size and weight admitted, each pony carrying about 140 lbs. The photographic apparatus caused us the greatest trouble, and had to be distributed between two beasts. As was to be expected, the guides who assisted us packed the nitrate of silver bath upside down ; an outrage the nature of which you cannot appreciate. At last everything was pretty well arranged,—guns, powder, shot, tea-kettles, rice, tents, beds, portable soups, etc., all stowed away—when the desponding Wilson came to me, his chin sweeping the ground, to say—that he very much feared the cook would die of the ride,—that he had never been on horseback in his life,—that as an experiment he had hired a pony that very morning at his own charges,—had been run away with, but having been caught and brought home by a honest Icelander, was now lying down—that position being the one he found most convenient.

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[1] The Puffin (*Alca arctica*)In Icelandic, *Soe-papagoie ;* In Scotland, *Priest ;* and in Cornwall, *Pope.*

As the first day's journey was two-and-thirty miles, and would probably necessitate his being twelve or thirteen hours in the saddle, I began to be really alarmed for my poor *chef;* but finding on inquiry that these gloomy prognostics were entirely voluntary on the part of Mr. Wilson, that the officer in question was full of zeal, and only too anxious to add horsemanship to his other accomplishments, I did not interfere. As for Wilson himself, it is not a marvel if he should see things a little *askew;* for some unaccountable reason, he chose to sleep last night in the open air, on the top of a hen coop, and naturally awoke this morning with a crick in his neck, and his face so immovably fixed over his left shoulder, that the efforts of all the ship's company have not been able to twist it back; with the help of a tackle, however, I think we shall eventually brace it square again.

At two we went to lunch with the Rector. The entertainment bore a strong family likeness to our last night's dinner; but as I wanted afterwards to exhibit my magic lantern to his little daughter Raghnilder, and a select party of her young friends, we contrived to elude doing full justice to it. During the remainder of the evening, like Job's children, we went about feasting from house to house, taking leave of friends who could not have been kinder had they known us all our lives, and interchanging little gifts and souvenirs. With the Governor I have left a print from the Princess Royal's drawing of the dead soldier in the Crimea. From the Rector of the cathedral church I have received some very curious books—almost the first printed in the island; I have been very anxious to obtain some specimens of ancient Icelandic manuscripts, but the island has long since been ransacked of its literary treasures; and to the kindness of the French consul I am indebted for a charming little white fox, the drollest and prettiest little beast I ever saw.

Having dined on board the "*Artemise*," we adjourned at eleven o'clock to the beach to witness the departure of the baggage. The ponies were all drawn up in one long file, the head of each being tied to the tail of the one immediately before him. Additional articles were stowed away here and there among the boxes. The last instructions were given by Sigurdr to the guides, and everything was declared ready for a start.

The jovial Wilson rides with us to-morrow. Unless we get his head round during the night, he will have to sit facing his horse's tail, in order to see before him.

We do not seem to run any danger of falling short of provisions, as by all accounts there are birds enough in the interior of the country to feed an Israëlitish emigration.

WILSON

LETTER VII.

KISSES—WILSON ON HORSEBACK—A LAVA PLATEAU—THINGVALLA — ALMANNAGIA — RABNAGIA — OUR TENT — THE SHIVERED PLAIN—WITCH-DROWNING—A PARLIAMENTARY DEBATE, A. D. 1000—THANGBRAND THE MISSIONARY—A GERMAN GNAT-CATCHER—THE MYSTICAL MOUNTAINS—SIR OLAF—HECKLA—SKAPTA JOKUL—THE FIRE DELUGE OF 1783—WE REACH THE GEYSIR—STROKR—FITZ'S BONNE FORTUNE—MORE KISSES—AN ERUPTION—PRINCE NAPOLEON—RETURN—TRADE—POPULATION—A MUTINY—THE REINE HORTENSE—THE SEVEN DUTCHMEN—A BALL—LOW DRESSES—NORTHWARD HO!

REYKJAVIK, July 7, 1856.

AT last I have seen the famous Geysirs, of which every one has heard so much; but I have also seen Thingvalla, of which no one has heard anything. The Geysirs are certainly wonderful marvels of nature, but more wonderful, more marvellous is Thingvalla; and if the one repay you for crossing the Spanish Sea, it would be worth while to go round the world to reach the other.

Of the boiling fountains I think I can give you a good idea, but whether I can contrive to draw for you anything like a comprehensible picture of the shape and nature of the Almannagja, the Hrafnagja, and the lava vale, called Thingvalla, that lies between them, I am doubtful. Before coming to Iceland I had read every account that had been written of Thingvalla by any former traveller, and when I saw it, it appeared to me a place of which I had never heard; so I suppose I shall come to grief in as melancholy a manner as my predecessors, whose ineffectual pages whiten the entrance to the valley they have failed to describe.

Having superintended—as I think I mentioned to you in my last letter—the midnight departure of the cook, guides, and luggage, we returned on board for a good night's rest, which we all needed. The start was settled for the next morning at eleven o'clock, and you may suppose we were not sorry to find, on waking, the bright joyous sunshine pouring down through the cabin skylight, and illuminating the white-robed, well-furnished breakfast-table with more than usual splendor. At the appointed hour we rowed ashore to where our eight ponies—two being assigned to each of us, to be ridden alternately—were standing ready bridled and saddled, at the house of one of our kindest friends. Of course, though but just risen from breakfast, the inevitable invitation to eat and drink awaited us; and another half-hour was spent in sipping cups of coffee poured out for us with much laughter by our hostess and her pretty daughter. At last, the necessary libations accomplished, we rose to go. Turning round to Fitz, I whispered, how I had always understood it was the proper thing in Iceland for travellers departing on a journey to kiss the ladies who had been good enough to entertain them,—little imagining he would take me at my word. Guess then my horror, when I suddenly saw him, with an intrepidity I envied but dared not imitate, first embrace the mamma, by way of prelude, and then proceed, in the most natural manner possible, to make the same tender advances to the daughter. I confess I remained dumb with consternation; the room swam round before me; I expected the next minute we should be packed neck and crop into the street, and that the young lady would have gone off into hysterics. It turned out, however, that such was the very last thing she was thinking of doing. With a simple frankness that became her more than all the boarding-school graces in the world, her eyes dancing with mischief and good humor, she met him half way, and pouting out two rosy lips, gave him as hearty a kiss as it might ever be the good fortune of one of us he-creatures to receive. From that moment I determined to conform for the future to the customs of the inhabitants.

Fresh from favors such as these, it was not surprising we should start in the highest spirits. With a courtesy peculiar to Iceland, Dr. Hjaltelin, the most jovial of doctors,—and another gentleman, insisted on conveying us the first dozen miles of our journey; and as we clattered away through the wooden streets, I think a merrier party never set out from Reykjavik. In front scampered the three spare ponies, without bridles, saddles, or any sense of moral responsibility, flinging up their heels, biting and neighing like mad things; then came Sigurdr, now become our chief, surrounded by the rest of the cavalcade; and finally, at a little distance, plunged in profound melancholy, rode Wilson. Never shall I forget his appearance. During the night his head had come partially straight, but by way of precaution, I suppose, he had conceived the idea of burying it down to the chin in a huge seal-skin helmet I had given him against the inclemencies of the Polar Sea. As on this occasion the thermometer was at 81°, and a *coup-de-soleil* was the chief thing to be feared, a ton of fur round his skull was scarcely necessary Seamen's trousers, a bright scarlet jersey, and jack-boots fringed with cat-skin, completed his costume; and as he proceeded along in his usual state of chronic consternation, with my rifle slung at his back and a couple of telescopes over his shoulder, he looked the image of Robinson Crusoe, fresh from having seen the foot-print.

A couple of hours' ride across the lava plain we had previously traversed brought us to a river, where our Reykjavik friends, after showing us a salmon weir, finally took their leave, with many kind wishes for our prosperity. On looking through the clear water that hissed and bubbled through the wooden sluice, the Doctor had caught sight of an apparently dead salmon, jammed up against its wooden bars; but on pulling him out, he proved to be still breathing, though his tail was immovably twisted into his mouth. A consultation taking place, the Doctors both agreed that it was a case of pleurosthotonos, brought on by mechanical injury to the spine (we had just been talking of Palmer's trial), and that he was perfectly fit for food. In accordance with this verdict, he was knocked on the head, and slung at Wilson's saddle-bow. Left to ourselves, we now pushed on as rapidly as we could, though the track across the lava was so uneven, that every moment I expected Snorro (for thus have I christened my pony) would be on his nose. In another hour we were among the hills. The scenery of this part of the journey was not very beautiful, the mountains not being remarkable either for their size or shape, but here and there we came upon pretty bits, not unlike some of the barren parts of Scotland, with quiet blue lakes sleeping in the solitude.

After wandering along for some time in a broad open valley, that gradually narrowed to a glen, we reached a grassy patch. As it was past three o'clock, Sigurdr proposed a halt.

Unbridling and unsaddling our steeds, we turned them loose upon the pasture, and sat ourselves down on a sunny knoll to lunch. For the first time since landing in Iceland I felt hungry; as, for the first time, four successive hours had elapsed without our having been compelled to take a snack. The appetites of the ponies seemed equally good, though probably with them hunger was no such novelty. Wilson looked sad. He confided to me privately that he feared his trousers would not last such jolting many days; but his dolefulness, like a bit of minor in a sparkling melody, only made our jollity more radiant. In about an hour Sigurdr gave the signal for a start; and having caught, saddled, and bridled three unridden ponies, we drove Snorro and his companions to the front, and proceeded on our way rejoicing. After an hour's gradual ascent through a picturesque ravine, we emerged upon an immense desolate plateau of lava, that stretched away for miles and miles like a great stony sea. A more barren desert you cannot conceive. Innumerable boulders, relics of the glacial period, encumbered the track. We could only go at a foot-pace. Not a blade of grass, not a strip of green, enlivened the prospect, and the only sound we heard was the croak of the curlew and the wail of the plover. Hour after hour we plodded on, but the grey waste seemed interminable, boundless; and the only consolation Sigurdr would vouchsafe was, that our journey's end lay on this side of some purple-mountains that peeped like the tents of a demon leaguer above the stony horizon.

As it was already eight o'clock, and we had been told the entire distance from Reykjavik to Thingvalla was only five-and-thirty miles, I could not comprehend how so great a space should still separate us from our destination. Concluding more time had been lost in shooting, lunching, etc., by the way than we had supposed, I put my pony into a canter, and determined to make short work of the dozen miles which seemed still to lie between us and the hills, on this side of which I understood from Sigurdr our encampment for the night was to be pitched.

Judge, then, of my astonishment when, a few minutes afterwards, I was arrested in full career by a tremendous precipice, or rather chasm, which suddenly gaped beneath my feet, and completely separated the barren plateau we had been so painfully traversing from a lovely, gay, sunlit flat, ten miles broad, that lay—sunk at a level lower by a hundred feet—between us and the opposite mountains. I was never so completely taken by surprise; Sigurdr's purposely vague description of our halting-place was accounted for.

We had reached the famous Almanna Gja. Like a black rampart in the distance, the corresponding chasm of the Hrafna Gja cut across the lower slope of the distant hills, and between them now slept in beauty and sunshine the broad verdant [1] plain of Thingvalla.

Ages ago,—who shall say how long?—some vast com-

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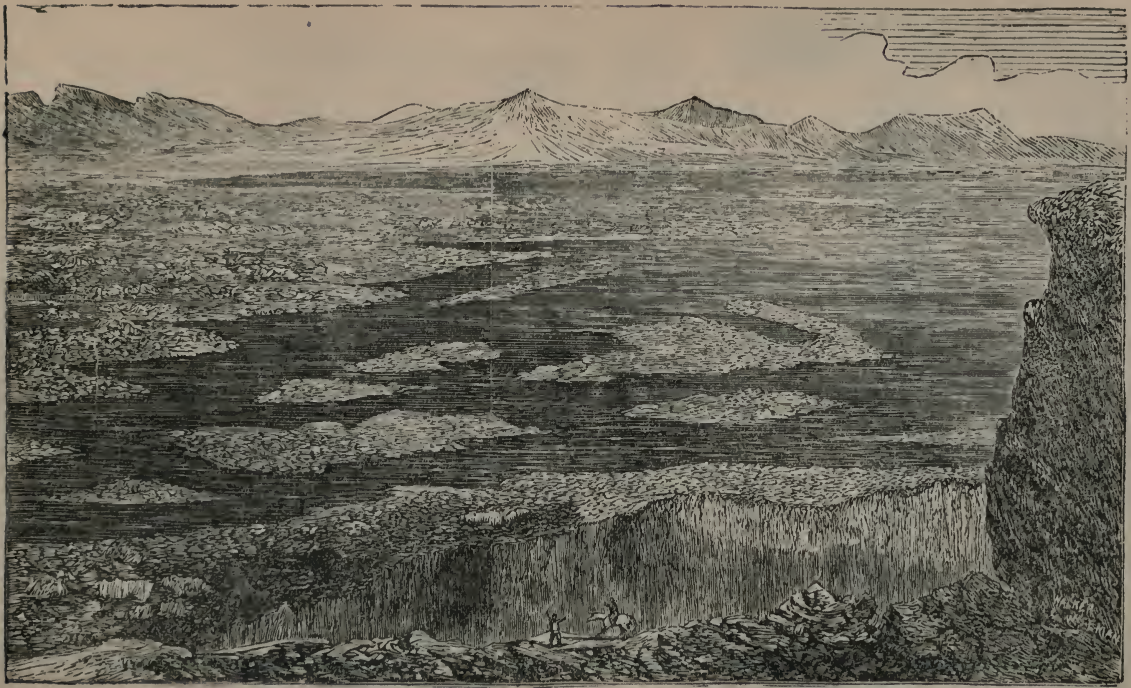
[1] The plain of Thingvalla is in a great measure clothed with birch brushwood.

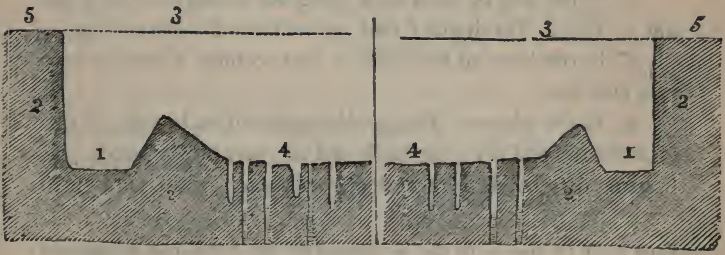


THE LAKE OF THINGVALLA.

motion shook the foundations of the island, and bubbling up from sources far away amid the inland hills, a fiery deluge must have rushed down between their ridges, until, escaping from the narrower gorges, it found space to spread itself into one broad sheet of molten stone over an entire district of country, reducing its varied surface to one vast blackened level.

One of two things then occurred: either the vitrified mass contracting as it cooled,—the centre area of fifty square miles burst asunder at either side from the adjoining plateau, and sinking down to its present level, left the two parallel Gjas, or chasms, which form its lateral boundaries, to mark the limits of the disruption; or else, while the pith or marrow of the lava was still in a fluid state, its upper surface became solid, and formed a roof beneath which the molten stream flowed on to lower levels, leaving a vast cavern into which the upper crust subsequently plumped down.[1]

The enclosed section will perhaps help you a little to comprehend what I am afraid my description will have failed to bring before you.



1 Gjas. 2 Lava deluge. 3 Original surface.
4 Thingvalla sunk to a lower level. 5 Astonished traveller.

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[1] I feel it is very presumptuous in me to hazard a conjecture on a subject with which my want of geological knowledge renders me quite incompetent to deal; but however incorrect either of the above suppositions may be justly considered by the philosophers, they will per-

1. Are the two chasms called respectively Almanna Gja,[1] or Main Gja, and Hrafna Gja, or Raven's Gja. In the act of disruption the sinking mass fell in, as it were, upon itself, so that one side of the Gja slopes a good deal back as it ascends; the other side is perfectly perpendicular, and at the spot I saw it upwards of one hundred feet high. In the lapse of years the bottom of the Almanna Gja has become gradually filled up to an even surface, covered with the most beautiful turf, except where a river, leaping from the higher plateau over the precipice, has chosen it for a bed. You must not suppose, however, that the disruption and land-slip of Thingvalla took place quite in the spick and span manner the section might lead you to imagine; in some places the rock has split asunder very unevenly, and the Hrafna Gja is altogether a very untidy rent, the sides having fallen in in many places, and almost filled up the ravine with ruins. On the other hand, in the Almanna Gja, you can easily distinguish on the one face marks and formations exactly corresponding, though at a different level, with those on the face opposite, so cleanly were they separated.

2. Is the sea of lava now lying on the top of the original surface. Its depth I had no means of ascertaining.

3. Is the level of the surface first formed when the lava was still hot.

4. Is the plain of Thingvalla, eight miles broad, its surface shattered into a network of innumerable crevices and fissures fifty or sixty feet deep, and each wide enough to

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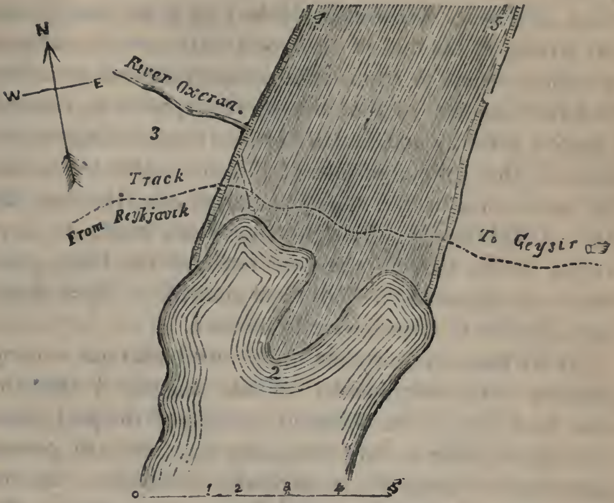
haps serve to convey to the unlearned reader, for whose amusement (not instruction) these letters are intended, the impression conveyed to my mind by what I saw, and so help out the picture I am trying to fill in for him.

[1] Almanna may be translated *main*; it means literally *all men's;* when applied to a road, it would mean the road along which all the world travel.

have swallowed the entire company of Korah. At the foot of the plain lies a vast lake, into which, indeed, it may be said to slope, with a gradual inclination from the north, the imprisoned waters having burst up through the lava strata, as it subsided beneath them. Gazing down through their emerald depths, you can still follow the pattern traced on the surface of the bottom, by cracks and chasms similar to those into which the dry portion of Thingvalla has been shivered.



1 Plain of Thingvalla 2 Lake.
3 Lava plateau. 4 Almanna Gja.
5 Rabna Gja.

The accompanying ground plan will, I trust, complete what is wanting to fill up the picture I so long to conjure up before the mind's eye. It is the last card I have to play, and, if unsuccessful, I must give up the task in despair.

But to return to where I left myself, on the edge of the cliff, gazing down with astonished eyes over the panorama of land and water embedded at my feet. I could scarcely speak for pleasure and surprise; Fitz was equally taken aback, and as for Wilson, he looked as if he thought we had arrived at the end of the world. After having allowed us sufficient time to admire the prospect Sigurdr turned to the left, along the edge of the precipice, until we reached a narrow pathway accidentally formed down a longitudinal niche in the splintered face of the cliff, which led across the bottom, and up the opposite side of the Gja, into the plain of Thingvalla. By rights our tents ought to have arrived before us, but when we reached the little glebe where we expected to find them pitched, no signs of servants, guides, or horses were to be seen.

As we had not overtaken them ourselves, their non-appearance was inexplicable. Wilson suggested that, the cook having died on the road, the rest of the party must have turned aside to bury him; and that we had passed unperceived during the interesting ceremony. Be the cause what it might, the result was not agreeable. We were very tired, very hungry, and it had just begun to rain.

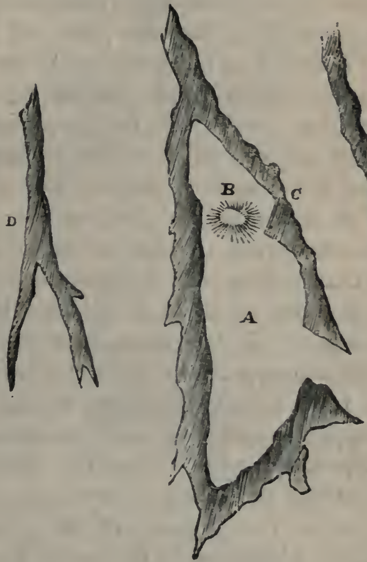
It is true there was a clergyman's house and a church, both built of stones covered with turf sods, close by; at the one, perhaps, we could get milk, and in the other we could sleep, as our betters—including Madame Pfeiffer—had done before us; but its inside looked so dark, and damp, and cold, and charnel-like, that one really doubted whether lying in the churchyard would not be snugger. You may guess, then, how great was my relief when our belated baggage-train was descried against the sky-line, as it slowly wended its way along the purple edge of the precipice towards the staircase by which we had already descended.

Half an hour afterwards the little plot of grass selected for the site of our encampment was covered over with poles, boxes, cauldrons, tea-kettles, and all the paraphernalia of a gipsy settlement. Wilson's Kaffir experience came at once into play, and under his solemn but effective superintendence, in less than twenty minutes the horn-headed tent rose, dry and taut upon the sward. Having carpeted the floor with oil-skin rugs, and arranged our three beds with their clean crisp sheets, blankets, and coverlets complete, at the back, he proceeded to lay out the dinner-table at the tent door with as much decorum as if we were expecting the Archbishop of Canterbury. All this time the cook, who looked a little pale, and moved, I observed with difficulty, was mysteriously closeted with a spirit-lamp inside a diminutive tent of his own, through the door of which the most delicious whiffs occasionally permeated. Olaf and his companions had driven off the horses to their pastures; and Sigurdr and I were deep in a game of chess. Luckily, the shower, which threatened us a moment, had blown over. Though now almost nine o'clock P. M., it was as bright as mid-day; the sky burned like a dome of gold, and silence and deep peace brooded over the fair grass-robed plain, that once had been so fearfully convulsed.

You may be quite sure our dinner went off merrily; the tetanus-afflicted salmon proved excellent, the plover and ptarmigan were done to a turn, the mulligatawny beyond all praise; but alas! I regret to add, that he—the artist, by whose skill these triumphs had been achieved—his task accomplished,—no longer sustained by the factitious energy resulting from his professional enthusiasm,—at last succumbed, and, retiring to the recesses of his tent, like Psyche in the "Princess," lay down, "and neither spoke nor stirred."

After another game or two of chess, a pleasant chat, a gentle stroll, we also turned in; and for the next eight hours perfect silence reigned throughout our little encampment, except when Wilson's sob-like snores shook to their foundation the canvas walls that sheltered him.

When I awoke—I do not know at what hour, for from this time we kept no account of day or night—the white sunlight was streaming into the tent, and the whole landscape was gleaming and glowing in the beauty of one of the hottest summer-days I ever remember. We breakfasted in our shirt-sleeves, and I was forced to wrap my head in a white handkerchief for fear of the sun. As we were all a little stiff after our ride, I could not resist the temptation of spending the day where we were, and examining more leisurely the wonderful features of the neighborhood. Independently of its natural curiosities, Thingvalla was most interesting to me on account of the historical associations connected with it. Here, long ago, at a period when feudal despotism was the only government known throughout Europe, free parliaments used to sit in peace, and regulate the affairs of the young Republic; and to this hour the precincts of its Commons House of Parliament are as distinct and unchanged as on the day when the high-hearted fathers of the emigration first consecrated them to the service of a free nation. By a freak of nature, as the subsiding plain cracked and shivered into twenty thousand fissures, an irregular oval area, of about two hundred feet by fifty, was left almost entirely surrounded by a crevice so deep and broad as to be utterly impassable;—at one extremity alone a scanty causeway connected it with the adjoining level, and allowed of access to its interior. It is true, just at one point the encircling chasm grows so narrow as to be within the possibility of a jump; and an ancient worthy, named Flosi, pursued by his enemies, did actually take it at a fly; but as leaping an inch short would have entailed certain drowning in the bright green waters that sleep forty feet below, you can conceive there was never much danger of this entrance becoming a thoroughfare. I confess that for one moment, while contemplating the scene of Flosi's exploit, I felt,—like a true Briton,—an idiotic desire to be able to say that I had done the same :—that I survive to write this letter is a proof of my having come subsequently to my senses.



A. The Althing.
B. The Hill of Laws.
C. The place where Flosi jumped.
D. Adjacent Chasm.

This spot then, erected by nature almost into a fortress, the founders of the Icelandic constitution chose for the meetings of their Thing,[1] or Parliament, armed guards defended the entrance, while the grave bonders deliberated in security within : to this day, at the upper end of the place of meeting, may be seen the three hammocks, where sat in state the chiefs and judges of the land.

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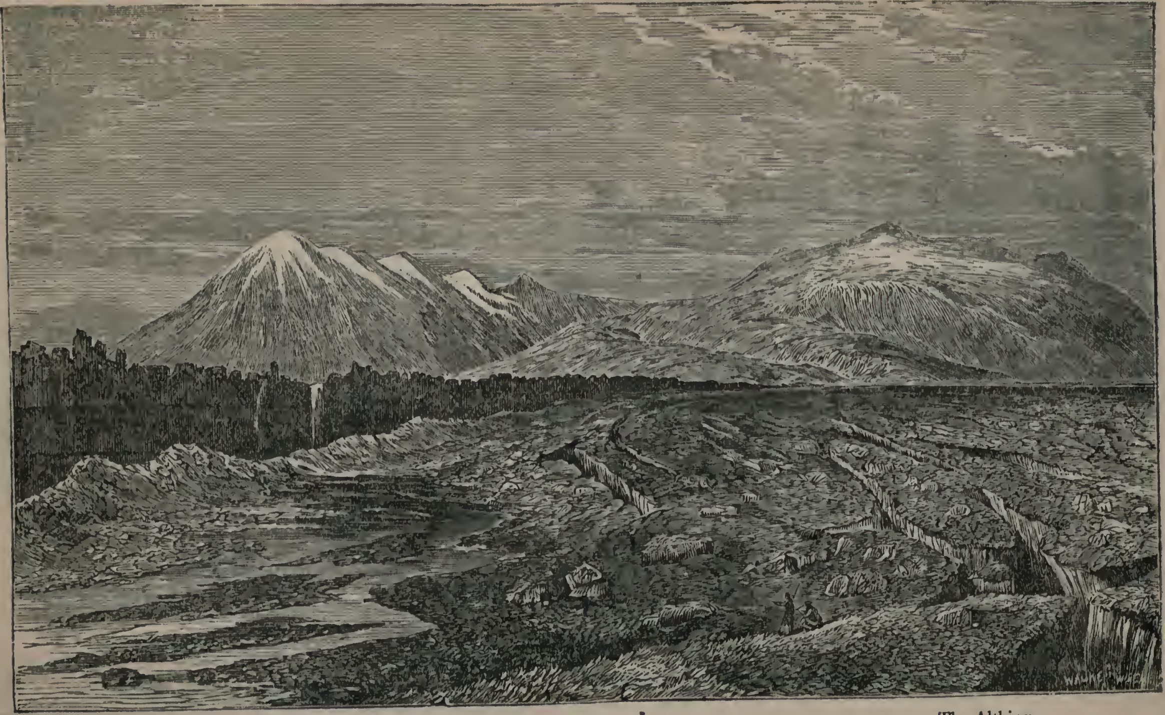
[1] From *thing*, to speak. We have a vestige of the same word in Dingwall, a town of Ross-shire.

But those grand old times have long since passed away. Along the banks of the Oxeraa no longer glisten the tents and booths of the assembled lieges; no longer stalwart berserks guard the narrow entrance to the Althing; ravens alone sit on the sacred Logberg; and the floor of the old Icelandic House of Commons is ignominiously cropped by the sheep of the parson. For three hundred years did the gallant little Republic maintain its independence—three hundred years of unequalled literary and political vigor. At last its day of doom drew near. Like the Scotch nobles in the time of Elizabeth, their own chieftains intrigued against the liberties of the Icelandic people; and in 1261 the island became an appanage of the Norwegian crown. Yet even the deed embodying the concession of their independence was drawn up in such haughty terms as to resemble rather the offer of an equal alliance than the renunciation of imperial rights. Soon, however, the apathy which invariably benumbs the faculties of a people too entirely relieved from the discipline and obligation of self-government, lapped in complete inactivity, moral, political, and intellectual,—these once stirring islanders. On the amalgamation of the three Scandinavian monarchies, at the union of Calmar, the allegiance of the people of Iceland was passively transferred to the Danish crown. Ever since that time, Danish proconsuls have administered their government, and Danish restrictions have regulated their trade. The traditions of their ancient autonomy have become as unsubstantial and obsolete as those which record vanished fame of their poets and historians, and the exploits of their mariners. It is true, the adoption of the Lutheran religion galvanized for a moment into the semblance of activity the old literary spirit. A printing-press was introduced as early as 1530, and ever since the six-



Almanna gia.

THINGVALLA.

The Althing.

teenth century many works of merit have been produced from time to time by Icelandic genius. Shakespeare, Milton, and Pope have been translated into the native tongue; one of the best printed newspapers I have ever seen is now published at Reykjavik; and the Colleges of Copenhagen are adorned by many an illustrious Icelandic scholar; but the glory of the old days is departed, and it is across a wide desolate flat of ignoble annals, as dull and arid as their own lava plains, that the student has to look back upon the glorious drama of Iceland's early history. As I gazed around on the silent, deserted plain, and paced to and fro along the untrodden grass that now clothed the Althing, I could scarcely believe it had ever been the battle-field where such keen and energetic wits encountered, —that the fire-scathed rocks I saw before me were the very same that had once inspired one of the most successful rhetorical appeals ever hazarded in a public assembly.

As an account of the debate to which I allude has been carefully preserved, I may as well give you an abstract of it. A more characteristic leaf out of the Parliamentary Annals of Iceland you could scarcely have.

In the summer of the year 1000, when Ethelred the Unready ruled in England, and fourteen years after Hugh Capet had succeeded the last Carlovingian on the throne of France,—the Icelandic legislature was convened for the consideration of a very important subject—no less important, indeed, than an inquiry into the merits of a new religion lately brought into the country by certain emissaries of Olaf Tryggveson,—the first Christian king of Nor way,—and the same who pulled down London bridge.

The assembly met. The Norse missionaries were called upon to enunciate to the House the tenets of the faith they were commissioned to disclose; and the debate began. Great and fierce was the difference of opinion. The good old Tory party, supported by all the authority of the Odin establishment, were violent in opposition. The Whigs advocated the new arrangement, and, as the king supported their own views, insisted strongly on the Divine right. Several liberal members permitted themselves to speak sarcastically of the Valhalla tap, and the ankles of Freya. The discussion was at its height, when suddenly a fearful peal of subterranean thunder roared around the Althing. "Listen!" cried an orator of the Pagan party; "how angry is Odin that we should even consider the subject of a new religion. His fires will consume us." To which a ready debater on the other side replied, by "begging leave to ask the honorable gentleman,—with whom were the gods angry when these rocks were melted?"—pointing to the devastated plain around him. Taking advantage of so good a hit, the Treasury "whips" immediately called for a division; and the Christian religion was adopted by a large majority.

The first Christian missionaries who came to Iceland seem to have had a rather peculiar manner of enforcing the truths of the Gospel. Their leader was a person of of the name of Thangbrand. Like the protestant clergymen Queen Elizabeth despatched to convert Ireland, he was bundled over to Iceland principally because he was too disreputable to be allowed to live in Norway. The old Chronicler gives a very quaint description of him. "Thangbrand," he says, "was a passionate, ungovernable person and a great man-slayer; but a good scholar, and clever. Thorvald, and Veterlid the Scald, composed a lampoon against him; but he killed them both outright. Thangbrand was two years in Iceland, and was the death of three men before he left it."

From the Althing we strolled over to the Almanna Gja, visiting the Pool of Execution on our way. As I have already mentioned, a river from the plateau above leaps over the precipice into the bottom of the Gja, and flows for a certain distance between its walls. At the foot of the fall the waters linger for a moment in a dark, deep, brimming pool, hemmed in by a circle of ruined rocks ; to this pool, in ancient times, all women convicted of capital crimes were immediately taken and drowned. Witchcraft seems to have been the principal weakness of ladies in those days, throughout the Scandinavian countries. For a long period no disgrace was attached to its profession. Odin himself, we are expressly told, was a great adept, and always found himself very much exhausted at the end of his performance ; which leads me to think that perhaps he dabbled in electro-biology. At last the advent of Christianity threw discredit on the practice ; severe punishments were denounced against all who indulged in it ; and in the end its mysteries became the monopoly of the Laplanders.

All criminals, men and women, were tried by juries ; and that the accused had the power of challenging the jurymen empannelled to try them, appears from the following extract from the Book of Laws :—" The judges shall go out on Washday, *i. e.*, Saturday, and continue out for challenges, until the sun comes on Thingvalla on the Lord's-day." And again, " The power of challenging shall cease as soon as the sun can be no longer seen above the western brink of the chasm, from the Logberg."

Turning aside from what, I dare say, was the scene of many an unrecorded tragedy, we descended the gorge of the Almanna Gja, towards the lake : and I took advantage of the opportunity again to examine its marvellous construction. The perpendicular walls of rock rose on either hand from the flat greensward that carpeted its bottom, pretty much as the waters of the Red sea must have risen on each side of the fugitive Israelites. A blaze of light smote the face of one cliff, while the other lay in the deepest shadow ; and on the rugged surface of each might still be traced corresponding articulations, that once had dove tailed into each other, ere the igneous mass was rent asunder. So unchanged, so recent seemed the vestiges of this convulsion, that I felt as if I had been admitted to witness one of nature's grandest and most violent operations, almost in the very act of its execution. A walk of about twenty minutes brought us to the borders of the lake—a glorious expanse of water, fifteen miles long, by eight miles broad, occupying a basin formed by the same hills, which must also, I imagine, have arrested the further progress of the lava torrent. A lovelier scene I have seldom witnessed. In the foreground lay huge masses of rock and lava, tossed about like the ruins of a world, and washed by waters as bright and green as polished malachite. Beyond a bevy of distant mountains, robed by the transparent atmosphere in tints unknown to Europe, peeped over each other's shoulders into the silver mirror at their feet, while here and there from among their purple ridges columns of white vapor rose like altar smoke toward the tranquil heaven.

On returning home we found dinner waiting for us. I had invited the clergyman, and a German gentleman who was lodging with him, to give us the pleasure of their company; and in ten minutes we had all become the best of friends. It is true the conversation was carried on in rather a wild jargon, made up of six different languages—Icelandic, English, German, Latin, Danish, French—but in spite of the difficulty with which he expressed himself, it was impossible not to be struck with the simple earnest character of my German convive. He was about five-and twenty, a "*doctor philosophiæ*," and had come to Iceland to catch gnats. After having caught gnats in Iceland, he intended, he said, to spend some years in catching gnats in Spain—the privacy of Spanish gnats, as it appears, not having been hitherto invaded. The truth is, my guest was an entomologist, and in the pursuit of the objects of his study was evidently prepared to approach hardships and danger with a serenity that would not have been unworthy of the apostle of a new religion. It was almost touching to hear him describe the intensity of his joy when perhaps days and nights of fruitless labors were at last rewarded by the discovery of some hitherto unknown little fly; and it was with my whole heart that, at parting, I wished him success in his career, and the fame that so much conscientious labor merited. From my allusion to this last reward, however, he seemed almost to shrink, and, with a sincerity it was impossible to doubt, disclaimed as ignoble so poor a motive as a thirst for fame. His was one of those calm laborious minds, seldom found but among the Teutonic race, that—pursuing day by day with single-minded energy some special object—live in a noble obscurity, and die at last content with the consciousness of having added one other stone to that tower of knowledge men are building up toward heaven, even though the world should never learn what strong and patient hands have placed it there.

The next morning we started for the Geysirs: this time dividing the baggage-train, and sending on the cook in light marching order, with the materials for dinner. The weather still remained unclouded, and each mile we advanced disclosed some new wonder in the unearthly landscape. A three hours' ride brought us to the Rabna Gja, the eastern boundary of Thingvalla, and, winding up its rugged face, we took our last look over the lovely plain beneath us, and then manfully set forward across the same kind of arid lava plateau as that which we had already traversed before arriving at the Almanna Gja. But instead of the boundless immensity which had then so much disheartened us, the present prospect was terminated by a range of quaint parti-colored hills, which rose before us in such fantastic shapes that I could not take my eyes off them. I do not know whether it was the strong coffee or the invigorating air that stimulated my imagination ; but I certainly felt convinced I was coming to some mystical spot—out of space, out of time—where I should suddenly light upon a green-scaled griffin, or golden-haired princess, or other *bonne fortune* of the olden days. Certainly a more appropriate scene for such an encounter could not be conceived, than that which displayed itself, when we wheeled at last round the flank of the scorched ridge we had been approaching. A perfectly smooth grassy plain, about a league square, and shaped like a horse-shoe, opened before us, encompassed by bare cinder-like hills, that rose round —red, black, and yellow—in a hundred uncouth peaks of ash and slag. Not a vestige of vegetation relieved the aridity of their vitrified sides, while the verdant carpet at their feet only made the fire-moulded circle seem more weird and impassable. Had I had a trumpet and a lance, I should have blown a blast of defiance on the one, and having shaken the other toward the four corners of the world, would have calmly waited to see what next might betide. Three arrows shot bravely forward would have probably resulted in the discovery of a trap-door with an iron ring ; but having neither trumpet, lance, nor arrow, we simply alighted and lunched : yet even then I could not help thinking how lucky it was that, not eating dates, we could not inadvertently fling their stones into the eyes of any inquisitive genie who might be in the neighborhood.

After the usual hour's rest and change of horses, we galloped away to the other side of the plain, and, doubling the further horn of the semicircle, suddenly found ourselves in a district as unlike the cinder mountains we had quitted as they had differed from the volcanic scenery of the day before. On the left lay a long rampart of green hills, opening up every now and then into Scottish glens and gorges, while from their roots to the horizon stretched a vast breadth of meadow-land, watered by two or three rivers, that wound, and twisted, and coiled about, like blue serpents. Here and there, white volumes of vapor, that rose in endless wreaths from the ground, told of mighty cauldrons at work beneath that moist cool verdant carpet; while large silvery lakes, and flat-topped isolated hills, relieved the monotony of the level land, and carried on the eye to where the three snowy peaks of Mount Hecla shone cold and clear against the sky.

Of course it was rather tantalizing to pass so near this famous burning mountain without having an opportunity of ascending it; but the expedition would have taken up too much time. In appearance Hecla differs very little from the innumerable other volcanic hills with which the island is studded. Its cone consists of a pyramid of stone and scoriæ, rising to the height of about five thousand feet, and welded together by bands of molten matter which have issued from its sides. From A.D. 1004 to 1766 there have been twenty-three eruptions, occurring at intervals which have varied in duration from six to seventy-six years. The one of 1766 was remarkably violent. It commenced on the 5th of April by the appearance of a huge pillar of black sand mounting slowly into the heavens, accompanied by subterranean thunders, and all the other symptoms which precede volcanic disturbances. Then a coronet of flame encircled the crater; masses of red rock, pumice, and magnetic stones were flung out with tremendous violence to an incredible distance, and in such continuous multitudes as to resemble a swarm of bees clustering over the mountain. One boulder of pumice six feet in circumference was pitched twenty miles away; another of magnetic iron fell at a distance of fifteen. The surface of the earth was covered, for a circuit of one hundred and fifty miles, with a layer of sand four inches deep; the air was so darkened by it, that at a place one hundred and forty miles off, white paper held up at a little distance could not be distinguished from black. The fishermen could not put to sea on account of darkness, and the inhabitants of the Orkney islands were frightened out of their senses by showers of what they thought must be black snow. On the 9th of April, the lava began to overflow, and ran for five miles in a south-westerly direction, whilst, some days later,—in order that no element might be wanting to mingle in this devil's charivari,—a vast column of water, like Robin Hood's second arrow, split up through the cinder pillar to the height of several hundred feet; the horror of the spectacle being further enhanced by an accompaniment of subterranean cannonading and dire reports, heard at a distance of fifty miles.

Striking as all this must have been, it sinks into comparative tameness and insignificance, beside the infinitely more terrible phenomena which attended the eruption of another volcano, called Skapta Jokul.

Of all countries in Europe, Iceland is the one which has been the most minutely mapped, not even excepting the ordnance survey of Ireland. The Danish Government seem to have had a hobby about it, and the result has been a chart so beautifully executed, that every little crevice, each mountain torrent, each flow of lava, is laid down with an accuracy perfectly astonishing. One huge blank, however, in the south-west corner of this map of Iceland, mars the integrity of its almost microscopic delineations. To every other part of the island the engineer has succeeded in penetrating; one vast space alone of about four hundred square miles has defied his investigation. Over the area occupied by the Skapta Jokul, amid its mountain-cradled fields of snow and icy ridges, no human foot has ever wandered. Yet it is from the bosom of this desert district that has descended the most frightful visitation ever known to have desolated the island.

This event occurred in the year 1783. The preceding winter and spring had been unusually mild. Toward the end of May, a light bluish fog began to float along the confines of the untrodden tracts of Skapta, accompanied in the beginning of June by a great trembling of the earth. On the 8th of that month, immense pillars of smoke collected over the hill country towards the north, and coming down against the wind in a southerly direction, enveloped the whole district of Sida in darkness. A whirlwind of ashes then swept over the face of the country, and on the 10th, innumerable fire spouts were seen leaping and flaring amid the icy hollows of the mountain, while the river Skapta, one of the largest in the island, having first rolled down to the plain a vast volume of fetid waters mixed with sand, suddenly disappeared.

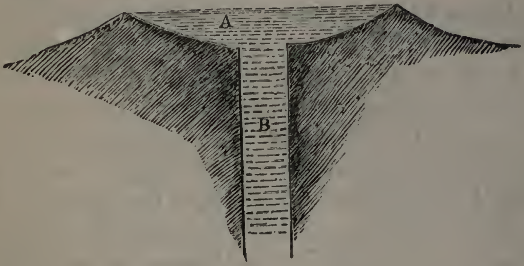
Two days afterwards a stream of lava, issuing from sources to which no one has ever been able to penetrate, came sliding down the bed of the dried-up river, and in a little time,—though the channel was six hundred feet deep and two hundred broad,—the glowing deluge overflowed its banks, crossed the low country of Meddalland, ripping the turf up before it like a table-cloth, and poured into a great lake whose affrighted waters flew hissing and screaming into the air at the approach of the fiery intruder. Within a few more days the basin of the lake itself was completely filled, and having separated into two streams, the unexhausted torrent again recommenced its march; in one direction overflowing some ancient lava fields,—in the other, re-entering the channel of the Skapta, and leaping down the lofty cataract of Stapafoss. But this was not all; while one lava flood had chosen the Skapta for its bed, another, descending in a different direction, was working like ruin within and on either side the banks of the Hverfisfliot, rushing into the plain, by all accounts, with even greater fury and velocity. Whether the two issued from the same crater it is impossible to say, as the sources of both were far away within the heart of the unapproachable desert, and even the extent of lava flow can only be measured from the spot where it entered the inhabited districts. The stream which flowed down Skapta is calculated to be about fifty miles in length by twelve or fifteen at its greatest breadth; that which rolled down the Hverfisfliot, at forty miles in length by seven in breadth. Where it was imprisoned, between the high banks of Skapta, the lava is five or six hundred feet thick; but as soon as it spread out into the plain its depth never exceeded one hundred feet. The eruption of sand, ashes, pumice, and lava, continued till the end of August, when the Plutonic drama concluded with a violent earthquake.

For a whole year a canopy of cinder-laden cloud hung over the island. Sand and ashes irretrievably overwhelmed thousands of acres of fertile pasturage. The Faroe islands, the Shetlands, and the Orkneys were deluged with volcanic dust, which perceptibly contaminated even the pure skies of England and Holland. Mephitic vapors tainted the atmosphere of the entire island;—even the grass, which no cinder rain had stifled, completely withered up;—the fish perished in the poisoned sea. A murrain broke out among the cattle, and a disease resembling scurvy attacked the inhabitants themselves. Stephenson has calculated that 9000 men, 28,000 horses, 11,000 cattle, 190,000 sheep, died from the effects of this one eruption. The most moderate calculation puts the number of human deaths at upwards of 1300; and of cattle, etc., at about 156,000.

The whole of this century had proved most fatal to the unfortunate people of Iceland. At its commencement small-pox destroyed more than 16,000 persons; nearly 10,000 more perished by a famine consequent on a succession of inclement seasons; while from time to time the southern coasts were considerably depopulated by the incursions of English and even Algerine pirates.

The rest of our day's journey lay through a country less interesting than the district we had traversed before luncheon. For the most part we kept on along the foot of the hills, stopping now and then for a drink of milk at the occasional farms perched upon their slopes. Sometimes turning up a green and even bushy glen (there are no trees in Iceland, the nearest approach to anything of the kind being a low dwarf birch, hardly worthy of being called a shrub), we would cut across the shoulder of some projecting spur, and obtain a wider prospect of the level land upon our right; or else keeping more down in the flat, we had to flounder for half an hour up to the horses' shoulders in an Irish bog. After about five hours of this work we reached the banks of a broad and rather singular river, called the Brúará. Half-way across it was perfectly fordable; but exactly in the middle was a deep cleft, into which the waters from either side spilt themselves, and then in a collected volume roared over a precipice a little lower down. Across this cleft some wooden planks were thrown, giving the traveller an opportunity of boasting that he had crossed a river on a bridge which itself was under water. By this time we had all begun to be very tired, and very hungry;—it was 11 o'clock P.M. We had been twelve or thirteen hours on horseback, not to mention occasional half-hours of pretty severe walking after the ptarmigan and plover. Many were the questions we addressed to Sigurdr on the distance yet remaining, and many the conjectures we hazarded as to whether the cook would have arrived in time to get dinner ready for us. At last, after another two hours' weary jogging, we descried, straight in front, a low steep brown rugged hill, standing entirely detached from the range at the foot of which we had been riding; and in a few minutes more, wheeling round its outer end, we found ourselves in the presence of the steaming Geysirs.

I do not know that I can give you a better notion of the appearance of the place than by saying that it looked as if —for about a quarter of a mile—the ground had been honey-combed by disease into numerous sores and orifices; not a blade of grass grew on its hot, inflamed surface, which consisted of unwholesome-looking red livid clay, or crumpled shreds or shards of slough-like incrustations. Naturally enough, our first impulse on dismounting was to scamper off at once to the Great Geysir. As it lay at the furthest end of the congeries of hot springs, in order to reach it we had to run the gauntlet of all the pools of boiling water and scalding quagmires of soft clay that intervened, and consequently arrived on the spot with our ankles nicely poulticed. But the occasion justified our eagerness. A smooth, silicious basin, seventy-two feet in diameter and four feet deep, with a hole at the bottom as in a washing-basin on board a steamer, stood before us brimful of water just upon the simmer; while up into the air above our heads rose a great column of vapor, looking as if it was going to turn into the Fisherman's Genie. The ground about the brim was composed of layers of incrustated silica, like the outside of an oyster, sloping gently down on all sides from the edge of the basin.



A. Basin. B. Funnel.

Having satisfied our curiosity with this cursory inspection of what we had come so far to see, hunger compelled us to look about with great anxiety for the cook; and you may fancy our delight at seeing that functionary in the very act of dishing up dinner on a neighboring hillock. Sent forward at an early hour, under the chaperonage of a guide, he had arrived about two hours before us, and seizing with a general's eye the key of the position, at once turned an idle, babbling little Geysir into a camp-kettle, dug a bake-house in the hot soft clay, and improvising a kitchen-range at a neighboring vent, had made himself completely master of the situation. It was about one o'clock in the morning when we sat down to dinner, and as light as day.

As the baggage-train with our tents and beds had not yet arrived, we fully appreciated our luck in being treated to so dry a night; and having eaten everything we could lay hands on, were sat quietly down to chess, and coffee brewed in Geysir water; when suddenly it seemed as if beneath our very feet a quantity of subterraneous cannon were going off; the whole earth shook, and Sigurdr, starting to his feet, upset the chess-board (I was just beginning to get the best of the game), and flung off full speed towards the great basin. By the time we reached its brim, however, the noise had ceased, and all we could see was a slight movement in the centre, as if an angel had passed by and troubled the water. Irritated at this false alarm, we determined to revenge ourselves by going and tormenting the Strokr. Strokr—or *the churn*—you must know, is an unfortunate Geysir, with so little command over his temper and his stomach, that you can get a *rise* out of him whenever you like. All that is necessary is to collect a quantity of sods, and throw them down his funnel. As he has no basin to protect him from these liberties, you can approach to the very edge of the pipe, about five feet in diameter, and look down at the boiling water which is perpetually seething at the bottom. In a few minutes the dose of turf you have just administered begins to disagree with him; he works himself up into an awful passion—tormented by the qualms of incipient sickness, he groans and hisses, and boils up, and spits at you with malicious vehemence, until at last, with a roar of mingled pain and rage, he throws up into the air a column of water forty feet high, which carries with it all the sods that have been chucked in, and scatters them scalded and half-digested at your feet. So irritated has the poor thing's stomach become by the discipline it has undergone, that even long after all the foreign matter has been thrown off, it goes on retching and sputtering, until at last nature is exhausted, when, sobbing and sighing to itself, it sinks back into the bottom of its den.

Put into high spirits by the success of this performance, we turned away to examine the remaining spring. I do not know, however, that any of the rest are worthy of particular mention. They all resemble in character the two I have described, the only difference being that they are infinitely smaller, and of much less power and importance. One other remarkable formation in the neighbourhood must not be passed unnoticed. Imagine a large irregular opening in the surface of the soft white clay, filled to the very brim with scalding water, perfectly still, and of as bright a blue as that of the Grotto Azzuro at Capri, through whose transparent depths you can see down into the mouth of a vast subaqueous cavern, which runs, Heaven knows how far, in a horizontal direction beneath your feet. Its walls and varied cavities really looked as if they were built of the purest lapis lazuli—and so thin seemed the crust that roofed it in, we almost fancied it might break through, and tumble us all into the fearful beautiful bath.

Having by this time taken a pretty good look at the principal features of our new domain, I wrapped myself up in a cloak and went to sleep; leaving orders that I should not be called until after the tent had arrived, and our beds were ready. Sigurdr followed my example, but the Doctor went out shooting.

As our principal object in coming so far was to see an eruption of the Great Geysir, it was of course necessary we should wait his pleasure; In fact, our movements entirely depended upon his. For the next two or three days, therefore, like pilgrims round some ancient shrine, we patiently kept watch; but he scarcely deigned to vouchsafe us the slightest manifestations of his latent energies. Two or three times the cannonading we had heard immediately after our arrival recommenced,—and once an eruption to the height of about ten feet occurred; but so brief was its duration, that by the time we were on the spot, although the tent was not eighty yards distant, all was over. As after every effort of the fountain the water in the basin mysteriously ebbs back into the funnel, this performance, though unsatisfactory in itself, gave us an opportunity of approaching the mouth of the pipe, and looking down into its scalded gullet. In an hour afterwards, the basin was brimful as ever.

Tethered down by our curiosity to a particular spot for an indefinite period, we had to while away the hours as best we could. We played chess, collected specimens, photographed the encampment, the guides, the ponies, and one or two astonished natives. Every now and then we went out shooting over the neighboring flats, and once I ventured on a longer expedition among the mountains to our left. The views I got were beautiful,—ridge rising beyond ridge in eternal silence, like gigantic ocean waves, whose tumult has been suddenly frozen into stone;—but the dread of the Geysir going off during my absence made me almost too fidgety to enjoy them. The weather luckily remained beautiful, with the exception of one little spell of rain, which came to make us all the more grateful for the sunshine,—and we fed like princes. Independently of the game, duck, plover, ptarmigan, and bittern, with which our own guns supplied us, a young lamb was always in the larder,—not to mention reindeer tongues, skier,—a kind of sour curds, excellent when well made,—milk, cheese, whose taste and nature baffles description, biscuit and bread, sent us as a free gift by the lady of the neighboring farm. In fact, so noble is Icelandic hospitality, that I really believe there was nothing within fifty miles round we might not have obtained for the asking, had we desired it. As for Fitz, he became quite the *enfant gâté* of a neighboring family.

Having unluckily caught cold, instead of sleeping in the tent, he determined to seek shelter under a solid roof-tree, and, conducted by our guide Olaf, set off on his pony at bed-time in search of a habitation. The next morning he reappeared so unusually radiant that I could not help inquiring what good fortune had in the meantime befallen him: upon which he gave me such an account of his last night's reception at the farm, that I was almost tempted to bundle tent and beds down the throat of our irritable friend Strokr, and throw myself for the future upon the hospitality of the inhabitants. It is true, I had read in Van Troil of something of the kind, but until now I never fully believed it. The Doctor shall tell his own story.

"No sooner," said he, "had I presented myself at the door, and made known my errand, than I was immediately welcomed by the whole family, and triumphantly inducted into the guest quarters: everything the house could produce was set before me, and the whole society stood by to see that I enjoyed myself. As I had but just dined an additional repast was no longer essential to my happiness; but all explanation was useless, and I did my best to give them satisfaction. Immediately on rising from the table, the young lady of the house—(old Van Troil says it is either the mother or the daughter of the house, if she be grown up, who performs this office)—proposed by signs to conduct me to my apartment; taking in one hand a large plate of skier, and in the other a bottle of brandy, she led the way through a passage built of turf and stones to the place where I was to sleep. Having watched her deposit—not without misgivings, for I knew it was expected both should be disposed of before morning—the skier by my bedside, and the brandy bottle under my pillow, I was preparing to make her a polite bow, and to wish her a very good night, when she advanced towards me, and with a winning grace difficult to resist, insisted upon helping me off with my coat and then,—proceeding to extremities,—with my shoes and stockings. At this most critical part of the proceedings, I naturally imagined her share of the performance would conclude, and that I should at last be restored to that privacy which at such seasons is generally considered appropriate. Not a bit of it. Before I knew where I was, I found myself sitting in a chair, in my shirt, trouserless, while my fair tire-woman was engaged in neatly folding up the ravished garments on a neighboring chair. She then in the most simple manner in the world, helped me into bed, tucked me up, and having said a quantity of pretty things in Icelandic, gave me a hearty kiss and departed. If," he added, "you see anything remarkable in my appearance, it is probably because—

'This very morn I've felt the sweet surprise
Of unexpected lips on sealed eyes;'

by which he poetically intimated the pleasing ceremony which had awaked him to the duties of the day. I think it needless to subjoin that the Doctor's cold did not get better as long as we remained in the neighborhood, and that, had it not been for the daily increasing fire of his looks, I should have begun to be alarmed at so protracted an indisposition.

We had how been keeping watch for three days over the Geysir, in languid expectation of the eruption which was to set us free. All the morning of the fourth day I had been playing chess with Sigurdr; Fitzgerald was photographing, Wilson was in the act of announcing luncheon, when a cry from the guides made us start to our feet, and with one common impulse rush towards the basin. The usual subterranean thunders had already commenced. A violent agitation was disturbing the centre of the pool. Suddenly a dome of water lifted itself up to the height of eight or ten feet,—then burst, and fell; immediately after which a shining liquid column, or rather a sheaf of columns wreathed in robes of vapor, sprung into the air, and in a succession of jerking leaps, each higher than the last, flung their silver crests against the sky. For a few minutes the fountain held its own, then all at once appeared to lose its ascending energy The unstable waters faltered, drooped, fell, "like a broken purpose," back upon themselves, and were immediately sucked down into the recesses of their pipe.

The spectacle was certainly magnificent; but no description can give any idea of its most striking features. The enormous wealth of water, its vitality, its hidden power,—the illimitable breadth of sunlit vapor, rolling out in exhaustless profusion.—all combined to make one feel the stupendous energy of nature's slightest movements.

And yet I do not believe the exhibition was so fine as some that have been seen: from the first burst upwards to the moment the last jet retreated into the pipe, was no more than a space of seven or eight minutes, and at no moment did the crown of the column reach higher than sixty or seventy feet above the surface of the basin. Now, early travellers talk of three hundred feet, which must, of course be fabulous; but many trustworthy persons have judged the eruptions at two hundred feet, while well-authenticated accounts—when the elevation of the jet has been actually measured—make it to have attained a height of upwards of one hundred feet.

With regard to the internal machinery by which these waterworks are set in motion, I will only say that the most received theory seems to be that which supposes the existence of a chamber in the heated earth, almost, but not quite filled with water, and communicating with the upper air by means of a pipe, whose lower orifice, instead of being in the roof, is at the side of the cavern, and *below* the surface of the subterranean pond. The water, kept by the surrounding furnaces at boiling point, generates of course a continuous supply of steam, for which some vent must be obtained; as it cannot escape by the funnel,—the lower mouth of which is under water,—it squeezes itself up within the arching roof until at last, compressed beyond all endurance, it strains against the rock, and pushing down the intervening waters with its broad, strong back, forces them below the level of the funnel, and dispersing part, and driving part before it, rushes forth in triumph to the upper air. The fountains, therefore, that we see mounting to the sky during an eruption are nothing but the superincumbent mass of waters in the pipe driven up in confusion before the steam at the moment it obtains its liberation.[1]

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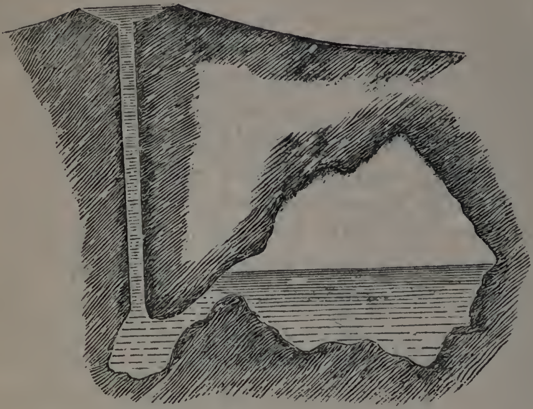
[1] Professor Bunsen has lately announced a chemical theory, which I believe has been received with favor by the scientific world. He points to the fact that water, after being long subjected to heat, loses much of the air contained in it, has the cohesion of its molecules much increased, and requires a higher temperature to bring it to boil; at which moment the production of vapor becomes so great, and so instantaneous, as to cause explosion. The bursting of furnace boilers is often attributable to this cause. Now, the water at the bottom of the well of the Great Geysir is found to be of constantly increasing temperature up to the moment of an eruption, when on one occasion it was as high as 261° Fahrenheit. Professor Bunsen's idea is that on

The accompanying sketch may perhaps help you to understand my meaning.



The last gulp of water had disappeared down the funnel. We were standing at the bottom of the now empty basin, gazing into each other's faces with joyous astonishment, when suddenly we perceived a horseman come frantically galloping round the base of the neighboring hill towards us. The state of the case was only too evident. He had seen the masses of vapor rising round the fountain, and guessing "what was *up*," had strained every nerve to arrive in time. As there was no mutual friend present to introduce us to each other,—of course under ordinary circumstances I should have wrapped myself in that reserve which is the birthright of every Briton, and pretended never even to have noticed his arrival; but the sight we had just seen had quite upset my nerves,—and I confess, with shame, that I so far compromised myself, as to inau-

reaching some unknown point above that temperature, ebullition takes place, vapor is suddenly generated in enormous quantity, and an eruption of the superior column of water is the consequence.

gurate a conversation with the stranger. In extenuation of my conduct, I must be allowed to add, that the newcomer was not a fellow-countryman, but of the French tongue, and of the naval profession.

Occupying then the door of my tent—by way of vantage ground, as soon as the stranger was come within earshot, I lifted up my voice, and cried in a style of Arabian familiarity, "O thou that ridest so furiously,—weary and disappointed one,—turn in, I pray thee, into the tent of thy servant, and eat bread, and drink wine, that thy soul may be comforted." To which he answered and said, "Man,—dweller in sulphureous places,—I will not eat bread, nor drink wine, neither will I enter into thy tent, until I have measured out a resting-place for my Lord the Prince."

At this interesting moment our acquaintance was interrupted by the appearance of two other horsemen—the one a painter, the other a geologist—attached to the expedition of Prince Napoleon. They informed us that His Imperial Highness had reached Reykjavik two days after we had left, that he had encamped last night at Thingvalla, and might be expected here in about four hours: they themselves having come on in advance to prepare for his arrival. My first care was to order coffee for the tired Frenchmen; and then—feeling that long residence having given us a kind of proprietorship in the Geysirs, we were bound to do the honors of the place to the approaching band of travellers,—I summoned the cook and enlarging in a long speech on the gravity of the occasion, gave orders that he should make a holocaust of all the remaining game, and get under way a plum-pudding, whose dimensions should do himself and England credit. A long table having been erected within the tent, Sigurdr started on a plundering expedition to the neighboring farm, Fitzgerald undertook the ordering of the feast, while I rode on my pony across the morass, in hopes of being able to shoot a few additional plover. In a couple of hours afterwards, just as I was stalking a duck that lay innocently basking on the bosom of the river, a cloud of horsemen swept round the base of the distant mountain, and returning home, I found the encampment I had left so deserted—alive and populous with as merry a group of Frenchmen as might ever be one's fortune to fall in with. Of course they were dressed in every variety of costume, long boots, picturesque brigand-looking hats, with here and there a sprinkling of Scotch caps from Aberdeen; but—whatever might be the head-dress, underneath you might be sure to find a kindly, cheery face. My old friend Count Trampe, who had accompanied the expedition, at once presented me to the Prince, who was engaged in sounding the depth of the pipe of the Great Geysir,—and encouraged by the gracious reception which His Imperial Highness accorded me, I ventured to inform him that "there was a poor banquet toward," of which I trusted he—and as many of his officers as the table could hold—would condescend to partake. After a little hesitation,—caused, I presume, by fear of our being put to inconvenience,—he was kind enough to signify his acceptance of my proposal, and in a few minutes afterwards with a cordial frankness I fully appreciated, allowed me to have the satisfaction of receiving him as a guest within my tent.

Although I never had the pleasure of seeing Prince Napoleon before, I should have known him among a thousand, from his remarkable likeness to his uncle, the first Emperor. A stronger resemblance, I conceive, could scarcely exist between two persons. The same delicate, sharply cut features, thin refined mouth, and firm determined jaw. The Prince's frame, however, is built altogether on a larger scale, and his eyes, instead of being of a cold piercing blue—are soft and brown, with quite a different expression.

Though of course a little Barmicidal, the dinner went off very well, as every dinner must do where such merry companions are the convives. We had some difficulty about stowing away the legs of a tall philosopher, and to each knife three individuals were told off; but the birds were not badly cooked, and the plum-pudding arrived in time to convert a questionable success into an undoubted triumph.

On rising from table, each one strolled away in whatever direction his particular taste suggested. The painter to sketch; the geologist to break stones; the philosopher to moralize, I presume,—at least he lighted a cigar,—and the rest to superintend the erection of the tents which had just arrived.

In an hour afterwards, sleep—though not altogether silence—for loud and strong rose the choral service intoned to Morpheus from every side—reigned supreme over the encampment, whose canvas habitations, huddled together on the desolated plateau, looked almost Crimean. This last notion, I suppose, must have mingled with my dreams, for not long afterwards I found myself in full swing towards a Russian battery, that banged and bellowed, and cannonaded about my ears in a fashion frightful to hear. Apparently I was serving in the French attack, for clear and shrill above the tempest rose the cry, "Alerte! alerte! aux armes, Monseigneur! aux armes!" The ground shook, volumes of smoke rose before my eyes, and completely hid the defences of Sebastopol; which fact, on reflection, I perceived to be the less extraordinary, as I was standing in my shirt at the door of a tent in Iceland. The premonitory symptoms of an eruption, which I had taken for a Russian cannonading, had awakened the French sleepers, —a universal cry was pervading the encampment,—and the entire settlement had turned out—chiefly in bare legs—to witness the event which the reverberating earth and steaming water seemed to prognosticate. Old Geysir, however, proved less courteous than we had begun to hope, for after laboring uneasily in his basin for a few minutes, he roused himself on his hind-legs—fell—made one more effort,—and then giving it up as a bad job, sank back into his accustomed inaction, and left the disappointed assembly to disperse to their respective dormitories.

The next morning, the whole encampment was stirring at an early hour with preparations for departure; for unsatisfactory as it had been, the French considered themselves absolved by the partial performance they had witnessed from any longer "making antechamber," as they said, to so capricious a functionary. Being very anxious to have one more trial at photographing Strokr, I ventured to suggest that the necessary bolus of sods should be administered to him. In a few minutes two or three cart-loads of turf were seething and wallowing within him. In the mean time, Fitz seized the opportunity of the Prince being at breakfast to do a picture of him seated on a chair, with his staff standing around him, and looking the image of Napoleon before the battle of Austerlitz. A good twenty minutes had now elapsed since the emetic had been given,—no symptoms of any result had as yet appeared,—and the French began to get impatient; inuendoes were hazarded to the disadvantage of Strokr's reputation for consistency,—inuendoes, which I confess touched me nearly, and made me feel like a showman whose dog has misbehaved. At last the whole party rode off; but the rear horseman had not disappeared round the neighboring hill before—splash! bang!—fifty feet up into the air drove the dilatory fountain, with a fury which amply avenged the affront put upon it, and more than vindicated my good opinion. All our endeavors, however, to photograph the eruption proved abortive. We had already attempted both Strokr and the Great Geysir, but in the case of the latter the exhibition was always concluded before the plate could be got ready; and although, as far as Strokr is concerned, you can tell within a certain period when the performance will take place, yet the interval occurring between the dose and the explosion varies so capriciously, that unless you are content to spend many days upon the spot, it would be almost impossible to hit it off exactly. On this last occasion,—although we did not prepare the plate until a good twenty minutes after the turf was thrown in,—the spring remained inactive so much longer than is usual that the collodion became quite insensitive, and the eruption left no impression whatever upon it.

Of our return journey to Reykjavik I think I have no very interesting particulars to give you. During the early part of the morning there had been a slight threatening of rain; but by twelve o'clock it had settled down into one of those still dark days, which wrap even the most familiar landscape in a mantle of mystery. A heavy, low-hung, steel-colored pall was stretched almost entirely across the heavens, except where along the flat horizon a broad stripe of opal atmosphere let the eye wander into space, in search of the pearly gateways of Paradise. On the other side rose the contorted lava mountains, their bleak heads knocking against the solid sky and stained of an inky blackness, which changed into a still more lurid tint where the local reds struggled up through the shadow that lay brooding over the desolate scene. If within the domain of nature such another region is to be found, it can only be in the heart of those awful solitudes which science has unveiled to us amid the untrodden fastnesses of the lunar mountains. An hour before reaching our old camping-ground at Thingvalla, as if summoned by enchantment, a dull grey mist closed around us, and suddenly confounded in undistinguishable ruin the glory and the terror of the panorama we had traversed ; sky, mountains, horizon, all had disappeared ; and as we strained our eyes from the edge of the Rabna Gja across the monotonous grey level at our feet, it was almost difficult to believe that there lay the same magical plain, the first sight of which had become almost an epoch in our lives.

I had sent on cook, baggage, and guides, some hours before we ourselves started, so that on our arrival we found a dry, cosy tent, and a warm dinner awaiting us. The rapid transformation of the aspect of the country, which I had just witnessed, made me quite understand how completely the success of an expedition in Iceland must depend on the weather, and fully accounted for the difference I had observed in the amount of enjoyment different travellers seemed to have derived from it. It is one thing to ride forty miles a day through the most singular scenery in the world, when a radiant sun brings out every feature of the country into startling distinctness, transmuting the dull tormented earth into towers, domes, and pinnacles of gleaming metal,—and weaves for every distant summit a robe of variegated light, such as the "Delectable Mountains" must have worn for the rapt gaze of weary "Christian ;"—and another to plod over the same forty miles, drenched to the skin, seeing nothing but the dim, grey roots of hills, that rise you know not how, and you care not where,—with no better employment than to look at your watch, and wonder when you shall reach your journey's end. If, in addition to this, you have to wait, as very often must be the case, for many hours after your own arrival, wet, tired, hungry, until the baggage-train, with the tents and food, shall have come up, with no alternative in the mean time but to lie shivering inside a grass-roofed church, or to share the quarters of some farmer's family, whose domestic arrangements resemble in every particular those which Macaulay describes as prevailing among the Scottish Highlanders a hundred years ago; and, if finally —after vainly waiting for some days to see an eruption which never takes place—you journey back to Reykjavik under the same melancholy conditions,—it will not be unnatural that, on returning to your native land you should proclaim Iceland, with her Geysirs, to be a sham, a delusion, and a snare!

Fortune, however, seemed determined that of these bitternesses we should not taste; for the next morning, bright and joyous overhead bent the blue unclouded heaven; while the plain lay gleaming at our feet in all the brilliancy of enamel. I was sorely tempted to linger another day in the neighborhood; but we have already spent more time upon the Geysirs than I had counted upon, and it will not do to remain in Iceland longer than the 15th, or Winter will have begun to barricade the passes into his Arctic dominions. My plan, on returning to Reykjavik, is to send the schooner round to wait for us in a harbor on the north coast of the island, while we ourselves strike straight across the interior on horseback.

The scenery, I am told, is magnificent. On the way we shall pass many a little nook, shut up among the hills, that has been consecrated by some touching old-world story; and the manner of life among the northern inhabitants is, I believe, more unchanged and characteristic than that of any other of the islanders. Moreover, scarcely any stranger has ever penetrated to any distance in this direction; and we shall have an opportunity of traversing a slice of that tremendous desert—piled up for thirty thousand square miles in disordered pyramids of ice and lava over the centre of the country, and periodically devastated by deluges of molten stone and boiling mud, or overwhelmed with whirlwinds of intermingled snow and cinders,—an unfinished corner of the universe, where the elements of chaos are still allowed to rage with unbridled fury.

Our last stage from Thingvalla back to Reykjavik was got over very quickly, and seemed an infinitely shorter distance than when we first performed it. We met a number of farmers returning to their homes from a kind of fair that is annually held in the little metropolis; and as I watched the long caravan-like line of pack-horses and horsemen, wearily plodding over the stony waste in single file, I found it less difficult to believe that these remote islanders should be descended from Oriental forefathers. In fact, one is constantly reminded of the East in Iceland. From the earliest ages the Icelanders have been a people dwelling in tents. In the time of the ancient Parliament, the legislators, during the entire session, lay encamped in movable booths around the place of meeting. Their domestic polity is naturally patriarchal, and the flight of their ancestors from Norway was a protest against the antagonistic principle of feudalism. No Arab could be prouder of his courser than they are of their little ponies, or reverence more deeply the sacred rights of hospitality; while the solemn salutation exchanged between two companies of travellers, passing each other in the *desert*—as they invariably call the uninhabited part of the country—would not have misbecome the stately courtesy of the most ancient worshippers of the sun.

Anything more multifarious than the landing of these caravans we met returning to the inland districts—cannot well be conceived; deal boards, rope, kegs of brandy, sacks of rye or wheaten flour, salt, soap, sugar, snuff, tobacco, coffee; everything, in fact, which was necessary to their domestic consumption during the ensuing winter. In exchange for these commodities, which of course they are obliged to get from Europe, the Icelanders export raw wool, knitted stockings, mittens, cured cod, and fish oil, whale blubber, fox skins, eider-down, feathers, and Icelandic moss. During the last few years the exports of the island have amounted to about 1,200,000 lbs. of wool and 500,000 pairs of stockings and mittens. Although Iceland is one-fifth larger than Ireland, its population consists of only about 60,000 persons, scattered along the habitable ring which runs round between the central desert and the sea; of the whole area of 38,000 square miles it is calculated that not more than one-eighth part is occupied, the remaining 33,000 square miles consisting of naked mountains of ice, or valleys desolated by lava or volcanic ashes. Even Reykjavik itself cannot boast of more than 700 or 800 inhabitants.

During winter time the men are chiefly employed in tending cattle, picking wool, manufacturing ropes, bridles, saddles, and building boats. The fishing season commences in spring; in 1853 there were as many as 3,500 boats engaged upon the water. As summer advances—turf-cutting and hay-making begins; while the autumn months are principally devoted to the repairing of their houses, manuring the grass lands, and killing and curing of sheep for exportation, as well as for their own use during winter. The woman-kind of a family occupy themselves throughout the year in washing, carding, and spinning wool, in knitting gloves and stockings, and in weaving frieze and flannel for their own wear.

The ordinary food of a well-to-do Icelandic family consists of dried fish, butter, sour whey kept till fermentation takes place, curds and skier—a very peculiar cheese unlike any I ever tasted,—a little mutton, and rye bread. As might be expected, this meagre fare is not very conducive to health; scurvy, leprosy, elephantiasis, and all cutaneous disorders, are very common, while the practice of mothers to leave off nursing their children at the end of three days, feeding them with cows' milk instead, results in a frightful mortality among the babies.

Land is held either in fee-simple, or let by the Crown to tenants on what may almost be considered perpetual leases. The rent is calculated partly on the number of acres occupied, partly on the head of cattle the farm is fit to support, and is paid in kind, either in fish or farm produce. Tenants in easy circumstances generally employ two or three laborers, who—in addition to their board and lodging—receive from ten to twelve dollars a year of wages. No property can be entailed, and if any one dies intestate, what he leaves is distributed among his children—in equal shares to the sons, in half shares to the daughters.

The public revenue arising from Crown lands, commercial charges, and a small tax on the transference of property, amounts to about 3,000*l.*; the expenditure for education, officers' salaries (the Governor has about 400*l.* a year), ecclesiastical establishments, etc., exceeds 6,000*l.* a year; so that the island is certainly not a self-supporting institution.

The clergy are paid by tithes; their stipends are exceedingly small, generally not averaging more than six or seven pounds sterling per annum; their chief dependence being upon their farms. Like St. Dunstan, they are invariably excellent blacksmiths.

As we approached Reykjavik, for the first time during the whole journey we began to have some little trouble with the relay of ponies in front. Whether it was that they were tired, or that they had arrived in a district where they had been accustomed to roam at large, I cannot tell; but every ten minutes, during the last six or seven miles, one or the other of them kept starting aside into the rocky plain, across which the narrow bridle-road was carried, and cost us many a weary chase before we could drive them into the track again. At last, though not till I had been violently hugged, kissed, and nearly pulled off my horse by an enthusiastic and rather tipsy farmer, who mistook me for the Prince, we galloped, about five o'clock, triumphantly into the town, without an accident having occurred to man or horse during the whole course of the expedition—always excepting one tremendous fall sustained by Wilson. It was on the evening of the day we left the Geysirs. We were all galloping in single file down the lava pathway, when suddenly I heard a cry behind me, and then the noise as of a descending avalanche. On turning round, behold! both Wilson and his pony lay stretched upon the ground, the first some yards in advance of the other. The poor fellow evidently thought he was killed; for he neither spoke nor stirred, but lay looking up at me with blank, beady eyes as I approached to his assistance. On further investigation neither of the sufferers proved to be a bit the worse.

The cook and the rest of the party, did not arrive till about midnight; but I make no doubt that when that able and spirited individual did at length reascend the side of the schooner, his cheek must have burned with pride at the reflection, that during the short period of his absence on shore he had added to his other accomplishments that of becoming a most finished cavalier. I do not mean by that to imply that he was at all *done.* Although we had enjoyed our trip so much, I was not sorry to find myself on board. The descent again, after our gipsy life, into the coquettish little cabin, with its books and dear home faces, quite penetrated me with that feeling of snug content of which I believe Englishmen alone are susceptible.

I have now to relate to you a most painful occurrence which has taken place during my absence at the Geysirs; —no less a catastrophe, in fact, than a mutiny among my hitherto most exemplary ship's company. I suppose they, too, had occasion to bear witness to the proverbial hospitality of Iceland; salt junk, and the innocuous cates which generally compose ship-board rations, could never have produced such an emergency. Suffice it to say, that "Dyspepsia and her fatal train" having taken hold of them, in a desperate hour they determined on a desperate deed, —and rushing aft in a body, demanded of my faithful steward, not only access to the penetralia of the absent Doctor's cupboard, but that he himself should administer to them whatever medicaments he could come by. In vain Mr. Grant threw himself across the cabin-door. Remonstrance was useless; my horny-handed lambs were inexorable—unless he acceded to their demands, they threatened to report him when I returned! The Doctor's sanctuary was thrown open, and all its sweets—if such they may be called—were rifled. A huge box of pills, the first that came to hand—they happened to be calomel—was served out, share and share alike, with concomitant vials of wrath, of rhubarb and senna; and it was not until the last drop of castor oil had been carefully licked up that the marauders suffered their unwilling accomplice to retire to the fastnesses of his pantry.

An avenging Nemesis, however, hovered over the violated shrine of Esculapius. By the time I returned the exigencies of justice had been more than satisfied, and the outrage already atoned for. The rebellious *hands* were become most penitent *stomachs;* and fresh from the Oriental associations suggested by our last day's ride, I involuntarily dismissed the disconsolate culprits, with the Asiatic form of condonation: "Mashallah, you have made your faces white! Go in peace!"

During our expedition to the interior, the harbor of Reykjavik had become populous with new arrivals. First of all there was my old friend, the "*Reine Hortense*," the Emperor's yacht, a magnificent screw corvette of 1,100 tons. I had last parted with her three years ago in the Baltic, after she had towed me for eighty miles on our way from Bomarsund to Stockholm. Then there were two English screw steamers of about 700 tons each, taken up by the French Government as tenders to the yacht; not to mention a Spanish brig, and one or two other foreigners, which, together with the frigate, the barque, and the vessels we had found here on our first arrival, made the usually deserted bay look quite lively. Until this year no steamers had ever cockneyfied its secluded waters.

This morning, directly after breakfast, I went on board the "*Reine Hortense*" to pay my respects to Prince Napoleon; and H. I. H. has just done me the honor of coming to inspect the "*Foam.*" When I was first presented to him at the Geysirs, he asked me what my plans might be; and on my mentioning my resolution of sailing to the North, he most kindly proposed that I should come with him West to Greenland instead. My anxiety, however, to reach, if it were possible, Jan Mayen and Spitzbergen, prevented my accepting this most tempting offer; but in the mean time, H. I. H. has, it seems, himself determined to come to Jan Mayen, and he is now kind enough to say that if I can get ready for a start by six o'clock to-morrow morning, the "*Reine Hortense*" shall take me in tow. To profit by this proposal would of course entail the giving up my plan of riding across the interior of Iceland, which I should be very loth to do; at the same time, the season is so far advanced, the mischances of our first start from England have thrown us so far behind in our programme, that it would seem almost a pity to neglect such an opportunity of overrunning the time that has been lost; and after all, these Polar islands, which so few have visited, are what I am chiefly bent on seeing. Before I close this letter the thing will have been settled one way or another; for I am to have the honor of dining with the Prince this evening, and between this and then I shall have made up my mind. After dinner there is to be a ball on board the frigate, to which all the rank, fashion, and beauty of Reykjavik have been invited.

3 A. M.

I give up seeing the rest of Iceland, and go North at once. It has cost me a struggle to come to this conclusion, but on the whole I think it will be better. Ten or fifteen days of summer-time become very precious in these latitudes, and are worth a sacrifice. At this moment we have just brought up astern of the "*Reine Hortense*" and are getting our hawsers bent, ready for a start in half an hour's time. My next letter, please God, will be dated from Hammerfest. I suppose I shall be about fifteen or twenty days getting there, but this will depend on the state of the ice about Jan Mayen. If the anchorage is clear, I shall spend a few days in examining the island, which by all accounts would appear to be most curious.

I happened first to hear of its existence from a very intelligent whaling Captain I fell in with among the Shetlands four years ago. He was sailing home to Hull, after fishing the Spitzbergen waters, and had sighted the huge mountain which forms the northern extremity of Jan Mayen, on his way south. Luckily, the weather was fine while he was passing, and the sketch he made of it at the time so filled me with amazement, that I then determined, if ever I got the chance, to go and see with my own eyes so great a marvel. Imagine a spike of igneous rock (the whole island is volcanic), shooting straight up out of the sea to the height of 6,870 feet, not broad-based like a pyramid, nor round-topped like a sugar-loaf, but, needle-shaped, pointed like the spire of a church. If only my Hull skipper were as good a draughtsman as he seemed to be a seaman, we should now be on our way to one of the wonders of the world. Most people here hold out rather a doleful prospect, and say that, in the first place, it is probable the whole island will be imprisoned within the eternal fields of ice, that lie out for upwards of a hundred and fifty miles along the eastern coast of Greenland; and next, that if even the sea should be clear in its vicinity, the fogs up there are so dense and constant that the chances are very much against our hitting the land. But the fact of the last French man-of-war which sailed in that direction never having returned, has made those seas needlessly unpopular at Reykjavik.

It was during one of these fogs that Captain Fotherby, the original discoverer of Jan Mayen, stumbled upon it in 1614. While sailing southwards in a mist too thick to see a ship's length off, he suddenly heard the noise of waters breaking on a great shore; and when the gigantic bases of Mount Beerenberg gradually disclosed themselves, he thought he had discovered some new continent. Since then it has been often sighted by homeward-bound whalers, but rarely landed upon. About the year 1633 the Dutch Government, wishing to establish a settlement in the actual neighborhood of the fishing-grounds, where the blubber might be boiled down, and the spoils of each season transported home in the smallest bulk,—actually induced seven seamen to volunteer remaining the whole winter on the island.[1] Huts were built for them, and having been furnished with an ample supply of salt provisions, they were left to resolve the problem, as to whether or no human beings could support the severities of the climate. Standing on the shore, these seven men saw their comrades' parting sails sink down beneath the sun,—then watched the sun sink, as had sunk the sails ;—but extracts from their own simple narrative are the most touching record I can give you of their fate :—

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[1] The names of the seven Dutch seamen who attempted to winter in Jan Mayen's Island were:

Outgert Jacobson, of Grootenbrook, their commander.
Adrian Martin Carman, of Schiedam, clerk.
Thauniss Thaunissen, of Schermehem, cook.
Dick Peterson, of Veenhuyse.
Peter Peterson, of Harlem.
Sebastian Gyse, of Defts-Haven.
Gerard Beautin, of Bruges.

"The 26th of August, our fleet set sail for Holland with a strong north-east wind, and a hollow sea, which continued all that night. The 28th, the wind the same ; it began to snow very hard ; we then shared half a pound of tobacco betwixt us, which was to be our allowance for a week. Towards evening we went about together, to see whether we could discover anything worth our observation ; but met with nothing." And so on for many a weary day of sleet and storm.

On the 8th of September they "were frightened by a noise of something falling to the ground,"—probably some volcanic disturbance. A month later, it becomes so cold that their linen, after a moment's exposure to the air becomes frozen like a board.[1] Huge fleets of ice beleaguered the island, the sun disappears, and they spend most of their time in "rehearsing to one another the adventures that had befallen them both by sea and land." On the 12th of December they kill a bear, having already begun to feel the effects of a salt diet. At last comes New Year's Day, 1636. "After having wished each other a happy new year, and success in our enterprise, we went to prayers, to disburthen our hearts before God." On the 25th of February (the very day on which Wallenstein was murdered) the sun reappeared. By the 22d of March scurvy had already declared itself: "For want of refreshments we began to be very heartless, and so afflicted that our legs are scarce able to bear us." On the 3d of April, "there being no more than two of us in health, we killed for them the only two pullets we had left; and they fed pretty heartily upon them, in hopes it might prove a means to recover part of their strength. We were sorry we had not a dozen more for their sake." On Easter Day, Adrian Carman, of Schiedam, their clerk, dies. "The Lord have mercy upon his soul, and upon us all, we being very sick." During the next few days they seem all to have got rapidly worse; one only is strong enough to move about. He has learnt writing from his comrades since coming to the island; and it is he who concludes the melancholy story. "The 23d (April), the wind blew from the same corner, with small rain. We were by this time reduced to a very deplorable state, there being none of them all, except myself, that were able to help themselves, much less one another, so that the whole burden lay upon my shoulders,—and I perform my duty as well as I am able, as long as God pleases to give me strength. I am just now a-going to help our commander out of his cabin, at his request, because he imagined by this change to ease his pain, he then struggling with death." For seven days this gallant fellow goes on "striving to do his duty;" that is to say, making entries in the journal as to the state of the weather, that being the principal object their employers had in view when they left them on the island; but on the 30th of April his strength too gave way, and his failing hand could do no more than trace an incompleted sentence on the page.

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[1] The climate, however, does not appear to have been then so inclement in these latitudes as it has since become. A similar deterioration in the temperature, both of Spitzbergen and Greenland, has also been observed. In Iceland we have undoubted evidence of corn having been formerly grown, as well as of the existence of timber of considerable size, though now it can scarcely produce a cabbage, or a stunted shrub of birch. M. Babinet, of the French Institute, goes a little too far when he says, in the *Journal des Débats* of the 30th December, 1856, that for many years Jan Mayen has been inaccessible.

Meanwhile succor and reward are on their way toward the forlorn garrison. On the 4th of June, up again above the horizon rise the sails of the Zealand fleet; but no glad faces came forth to greet the boats as they pull towards the shore; and when their comrades search for those they had hoped to find alive and well,—lo! each lies dead in his own hut,—one with an open Prayer-book by his side; another with his hand stretched out towards the ointment he had used for his stiffened joints; and the last survivor, with the unfinished journal still lying by his side.

The most recent recorded landing on the island was effected twenty-two years ago, by the brave and pious Captain, now Dr. Scoresby,[1] on his return from a whaling cruise. He had seen the mountain of Beerenberg one hundred miles off, and, on approaching, found the coast quite clear of ice. According to his survey and observations, Jan Mayen is about sixteen miles long, by four wide; but I hope soon, on my own authority, to be able to tell you more about it.

Certainly, this our last evening spent in Iceland will not have been the least joyous of our stay. The dinner on board the "*Reine Hortense*" was very pleasant. I renewed acquaintance with some of my old Baltic friends, and was presented to two or three of the Prince's staff who did not accompany the expedition to the Geysirs; among others, to the Duc d'Abrantes, Marshal Junot's son. On sitting down to table, I found myself between H.I.H. and Monsieur de Saulcy, member of the French Institute, who made that famous expedition to the Dead Sea, and is one of the gayest, pleasantest persons I have ever met. Of course there was a great deal of laughing and talking, as well as much speculation with regard to the costume of the Icelandic ladies we were to see at the ball.

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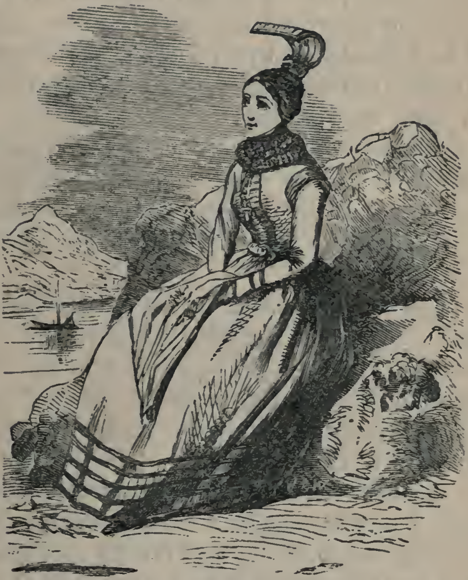
[1] I regret to be obliged to subjoin that Dr. Scoresby has died since the above was written.

It appears that the dove-cots of Reykjavik have been a good deal fluttered by an announcement emanating from the gallant Captain of the "*Artemise*" that his fair guests would be expected to come in low dresses; for it would seem that the practice of showing their ivory shoulders is, as yet, an idea as shocking to the pretty ladies of this country as waltzes was to our grandmothers. Nay, there was not even to be found a native milliner equal to the task of marking out that mysterious line which divides the prudish from the improper; so that the Collet-monté faction have been in despair. As it turned out, their anxiety on this head was unnecessary; for we found, on entering the ball-room, that, with the natural refinement which char-



AN ICELANDIC LADY.

acterizes this noble people, our bright-eyed partners, as if by inspiration, had hit off the exact sweep from shoulder to shoulder, at which—after those many oscillations, up and down, which the female corsage has undergone since the time of the first Director—good taste has finally arrested it.

I happened to be particularly interested in the above important question; for up to that moment I had always been haunted by a horrid paragraph I had met with somewhere in an Icelandic book of travels, to the effect that it was the practice of Icelandic women, from early childhood, to flatten down their bosoms as much as possible. This fact, for the honor of the island, I am now in a position to deny; and I here declare that, as far as I had the indiscretion to observe, those maligned ladies appeared to me as buxom in form as any rosy English girl I have ever seen.

It was nearly nine o'clock before we adjourned from the "*Reine Hortense*," to the ball. Already, for some time past, boats full of gay dresses had been passing under the corvette's stern on their way to the "*Artemise*," looking like flower-beds that had put to sea,—though they certainly could no longer be called a *parterre*;—and by the time we ourselves mounted her lofty sides, a mingled stream of music, light, and silver laughter, was pouring out of every port-hole. The ball-room was very prettily arranged. The upper deck had been closed in with a lofty roof of canvas, from which hung suspended glittering lustres, formed by bayonets with their points collected into an inverted pyramid, and the butt-ends serving as sockets for the tapers. Every wall was gay with flags,—the frigate's frowning armament all hid or turned to ladies uses: 82 pounders became sofas—boarding-pikes, balustrades—pistols, candlesticks—the brass carronades set on end, pillarwise, their brawling mouths stopped with nosegays; while portraits of the Em peror and the Empress, busts, colors draped with Parisian cunning, gave to the scene an appearance of festivity that looked quite fairy-like in so sombre a region. As for our gallant host, I never saw such spirits; he is a fine old grey-headed blow-hard of fifty odd, talking English like a native, and combining the frank open-hearted cordiality of a sailor with that graceful winning gaiety peculiar to Frenchmen. I never saw anything more perfect than the kind, almost fatherly, courtesy with which he welcomed each blooming bevy of maidens that trooped up his ship's side. About two o'clock we had supper on the main deck. I had the honor of taking down Miss Thora, of Bessestad; and somehow—this time, I no longer found myself wandering back in search of the pale face of the old-world Thora, being, I suppose, sufficiently occupied by the soft, gentle eyes of the one beside me. With the other young ladies I did not make much acquaintance, as I experienced a difficulty in finding befitting remarks on the occasion of being presented to them. Once or twice, indeed, I hazarded, through their fathers, some little complimentary observations in Latin; but I cannot say that I found that language lend itself readily to the gallantries of the ball-room. After supper dancing recommenced, and the hilarity of the evening reached its highest pitch when half a dozen sailors, dressed in turbans made of flags (one of them a lady with the face of the tragic muse), came forward and danced the cancan, with a gravity and decorum that would have greatly edified what Gavarni calls "*la pudeur municipale.*"

At 3 o'clock A. M. I returned on board the schooner, and we are all now very busy in making final preparations for departure. Fitz is rearranging his apothecary's shop. Sigurdr is writing letters. The last strains of music have ceased on board the "*Artemise;*" the sun is already high in the heavens; the flower-beds are returning on shore,—a little draggled perhaps, as if just pelted by a thunderstorm; the "*Reine Hortense*" has got her steam up, and the real, serious part of our voyage is about to begin.

I feel that my description has not half done justice to the wonders of this interesting island; but I can refer you to your friend Sir Henry Holland for further details; he paid a visit to Iceland in 1810, with Sir G. Mackenzie, and made himself thoroughly acquainted with its historical and scientific associations.

CONCLUDING ACT.

SCENE. *R. Y. S. "Foam": astern of the "Reine Hortense."*

DRAMATIS PERSONÆ.

VOICE OF FRENCH CAPTAIN, COMMANDING "R. H."
LORD D.
DOCTOR.
WILSON.

Voice of French Captain.—"Nous partons."

Lord D——.—"All ready, Sir!"

Wilson to Doctor (sotto voce).—"Sir!"

Doctor.—"Eh?"

Wilson.—"Do you know, Sir?"

Doctor.—"What?"

Wilson.—"Oh, nothing, Sir;—only we're going to the hicy regions, Sir, ain't we? Well, I've just seen that ere brig as is come from there, Sir, and they say there's a precious lot of ice this year! (*Pause.*) Do you know, Sir, the skipper showed me the bows of his vessel, Sir? She's got seven feet of solid timber in her for'ard: *we've* only two inches, Sir!" (*Dives below.*)

Voice of French Captain (with a slight accent).—"Are you ready?"

Lord D——.—"Ay, ay, Sir! Up anchor!"

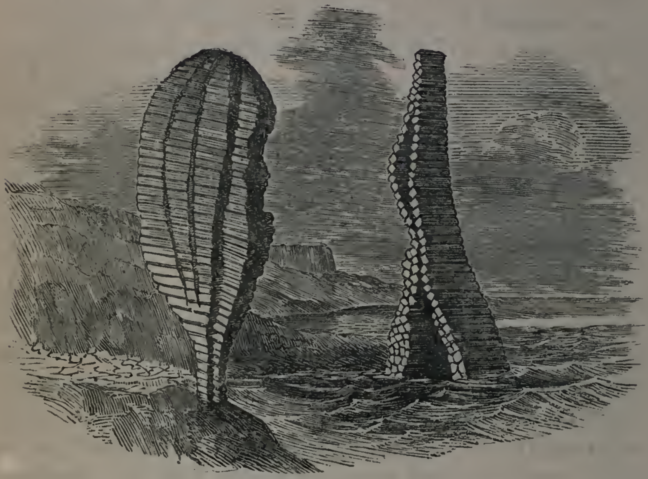
LETTER VIII.

START FROM REYKJAVIK—SNAEFELL—THE LADY OF FRODA—A BERSERK TRAGEDY—THE CHAMPION OF BREIDAVIK—ONUNDER FIORD—THE LAST NIGHT—CROSSING THE ARCTIC CIRCLE—FETE ON BOARD THE "REINE HORTENSE"—LE PÈRE ARCTIQUE—WE FALL IN WITH THE ICE—THE "SAXON" DISAPPEARS—MIST—A PARTING IN A LONELY SPOT—JAN MAYEN—MOUNT BEERENBERG—AN UNPLEASANT POSITION—SHIFT OF WIND AND EXTRICATION—"TO NORROWAY OVER THE FAEM"—A NASTY COASTHAMMERFEST.

HAMMERFEST, July.

BACK in Europe again,—within reach of posts! The glad sun shining, the soft winds blowing, and roses on the cabin table,—as if the region of fog and ice we have just fled forth from were indeed the dream-land these summer sights would make it seem. I cannot tell you how gay and joyous it all appears to us, fresh from a climate that would not have been unworthy of Dante's Inferno. And yet—had it been twice as bad, what we have seen would have more than repaid us, though it has been no child's play to get to see it.

But I must begin where I left off in my last letter,—just, I think, as we were getting under way, to be towed by the "*Reine Hortense*" out of Reykjavik Harbor. Having been up all night,—as soon as we were well clear of the land, and that it was evident the towing business was doing well—I turned in for a few hours. When I came on deck again we had crossed the Faxe Fiord on our way north, and were sweeping round the base of Snaefell—an extinct volcano which rises from the sea in an icy cone to the height of 5,000 feet, and grimly looks across to Greenland. The day was beautiful; the mountain's summit beamed down upon us in unclouded splendor, and everything seemed to promise an uninterrupted view of the west coast of Iceland, along whose rugged cliffs few mariners have ever sailed. Indeed, until within these last few years, the passage, I believe, was altogether impracticable, in consequence of the continuous fields of ice which used to drift down the narrow channel between the frozen continent and the northern extremity of the island. Lately, some great change seems to have taken place in the lie of the Greenland ice; and during the summer-time you can



REMAINS OF BASALTIC DYKES.

pass through, though late in the year a solid belt binds the two shores together.

But in a historical and scientific point of view, the whole country lying about the basanite roots of Snaefell is most interesting. At the feet of its southern slopes are to be seen wonderful ranges of columnar basalt, prismatic caverns, ancient craters, and specimens of almost every formation that can result from the agency of subterranean fires; while each glen, and bay, and headland, in the neighborhood, teems with traditionary lore. On the north-western side of the mountain stretches the famous Eyrbiggja district, the most classic ground in Iceland, with the towns, or rather farmsteads, of Froda, Helgafell, and Biarnarhaf.

This last place was the scene of one of the most curious and characteristic Sagas to be found in the whole catalogue of Icelandic chronicles.

In the days when the same Jarl Hakon I have already mentioned lorded it over Norway, an Icelander of the name of Vermund, who had come to pay his court to the lord of Lade, took a violent wish to engage in his own service a couple of gigantic Berserks,[1] named Halli and Leikner, whom the Jarl had retained about his person—fancying that two champions of such great strength and prowess would much add to his consequence on returning home. In vain the Jarl warned him that personages of that description were wont to give trouble and become unruly,—nothing would serve but he must needs carry them away with him; nay, if they would but come, they might ask as wages any boon which might be in his power to grant. The bargain accordingly was made; but on arriving in Iceland, the first thing Halli took into his head to require was a wife, who should be rich, nobly born, and beautiful. As such a request was difficult to comply with, Vermund, who was noted for being a man of gentle disposition, determined to turn his troublesome retainers over to his brother, Arngrim Styr. *i.e.*, the Stirring or Tumultuous One,—as being a likelier man than himself to know how to keep them in order.

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[1] Berserk, *i. e.*, bare sack. The berserks seem to have been a description of athletes who were in the habit of stimulating their nervous energies by the use of some intoxicating drug, which rendered them capable of feats of extraordinary strength and daring. The Berserker gang must have been something very like the Malay custom of running a muck. Their moments of excitement were followed by periods of great exhaustion.

Arngrim happened to have a beautiful daughter, named Asdisa, with whom the inflammable Berserk of course fell in love. Not daring openly to refuse him, Arngrim told his would-be son-in-law, that before complying with his suit, he must consult his friends, and posted off to Helgafell, where dwelt the Pagan Pontiff Snorre. The result of this conference was an agreement on the part of Styr to give his daughter to the Berserk, provided he and his brother would *cut* a road through the lava rocks of Biarnarhaf. Halli and Leikner immediately set about executing this prodigious task; while the scornful Asdisa, arrayed in her most splendid attire, came sweeping past in silence, as if to mock their toil. The poetical reproaches addressed to the young lady on this occasion by her sturdy admirer and his mate are still extant. In the mean time, the other servants of the crafty Arngrim had constructed a subterranean bath, so contrived that at a moment's notice it could be flooded with boiling water. Their task at last concluded, the two Berserks returned home to claim their reward; but Arngrim Styr, as if in the exuberance of his affection, proposed that they should first refresh themselves in the new bath. No sooner had they descended into it, that Arngrim shut down the trapdoor, and having ordered a newly-stripped bullock's hide to be stretched before the entrance, gave the signal for the boiling water to be turned on. Fearful were the struggles of the scalded giants; Halli, indeed, succeeded in bursting up the door ; but his foot slipped on the bloody bull's hide and Arngrim stabbed him to the heart. His brother was then easily forced back into the seething water.

The effusion composed by the Tumultuous One on the occasion of this exploit is also extant, and does not yield in poetical merit to those which I have already mentioned as having emanated from his victims.

As soon as the Pontiff Snorre heard of the result of Arngrim Styr's stratagem, he came over and married the Lady Asdisa. Traces of the road made by the unhappy champions can yet be detected at Biarnarhaf, and tradition still identifies the grave of the Berserks.

Connected with this same Pontiff Snorre is another of those mysterious notices of a great land in the western ocean which we find in the ancient chronicles, so interwoven with narrative we know to be true, as to make it impossible not to attach a certain amount of credit to them. This particular story is the more interesting as its *dénouement*, abruptly left in the blankest mystery by one Saga, is incidentally revealed to us in the course of another, relating to events with which the first had no connection.[1]

It seems that Snorre had a beautiful sister named Thured of Froda, with whom a certain gallant gentleman—called Bjorn, the son of Astrand—fell head and ears in love. Unfortunately, a rich rival appears in the field ; and though she had given her heart to Bjorn, Snorre—who, we have already seen, was a prudent man—insisted upon her giving her hand to his rival. Disgusted by such treatment, Bjorn sails away to the coasts of the Baltic, and joins a famous company of sea-rovers, called the Jomsburg Vikings. In this worthy society he so distinguishes himself by his valor and daring that he obtains the title of the Champion of

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[1] From internal evidence it is certain that the chronicle which contains these Sagas must have been written about the beginning of the thirteenth century.

Breidavik. After many doughty deeds, done by sea and land, he at last returns, loaded with wealth and honors, to his native country.

In the summer-time of the year 999, soon after his arrival was held a great fair at Froda, whither all the merchants, "clad in colored garments," congregated from the adjacent country. Thither came also Bjorn's old love, the Lady of Froda; "and Bjorn went up and spoke to her, and it was thought likely their talk would last long since they for such a length of time not seen each other." But to this renewal of old acquaintance both the lady's husband and her brother very much objected; and "it seemed to Snorre that it would be a good plan to kill Bjorn." So, about the time of hay-making, off he rides, with some retainers, to his victim's home, having fully instructed one of them how to deal the first blow. Bjorn was in the home-field (tùn), mending his sledge, when the cavalcade appeared in sight; and, guessing what motive had inspired the visit, went straight up to Snorre, who rode in front, "in a blue cloak," and held the knife with which he had been working in such a position as to be able to stab the Pontiff to the heart, should his followers attempt to lift their hands against himself. Comprehending the position of affairs, Snorre's friends kept quiet. "Bjorn then asked the news." Snorre confesses that he had intended to kill him; but adds, "Thou tookest such a lucky grip of me at our meeting, that thou must have peace this time, however it may have been determined before." The conversation is concluded by an agreement on the part of Bjorn to leave the country as he feels it impossible to abstain from paying visits to Thured as long as he remains in the neighborhood. Having manned a ship, Bjorn put to sea in the summer-time. "When they sailed away, a north-east wind was blowing, which wind lasted long during that summer; but of this ship was nothing heard since this long time." And so we conclude it is all over with the poor Champion of Breidavik! Not a bit of it. He turns up, thirty years afterwards, safe and sound, in the uttermost parts of the earth.

In the year 1029, a certain Icelander, named Gudlief, undertakes a voyage to Limerick, in Ireland. On his return home, he is driven out of his course by north-east winds, Heaven knows where. After drifting for many days to the west-ward, he at last falls in with land. On approaching the beach, a great crowd of people came down to meet the strangers, apparently with no friendly intentions. Shortly afterwards, a tall and venerable chieftain makes his appearance and, to Gudlief's great astonishment, addresses him in Icelandic. Having entertained the weary mariners very honorably, and supplied them with provisions, the old man bids them speed back to Iceland, as it would be unsafe for them to remain where they were. His own name he refused to tell; but having learnt that Gudlief comes from the neighborhood of Snaefell, he puts into his hands a sword and a ring. The ring is to be given to Thured of Froda; the sword to her son Kjartan. When Gudlief asks by whom he is to say the gifts are sent, the ancient chieftain answers, "Say they come from one who was a better friend of the Lady of Froda than of her brother Snorre of Helgafell." Wherefore it is conjectured that this man was Bjorn the son of Astrand, Champion of Breidavik.

After this, Madam, I hope I shall never hear you depreciate the constancy of men. Thured had better have married Bjorn after all!

I forgot to mention that when Gudlief landed on the strange coast, it seemed to him that the inhabitants spoke Irish. Now, there are many antiquaries inclined to believe in the former existence of an Irish colony to the southward of the Vinland of the Northmen. Scattered through the Sagas are several notices of a distant country in the West, which is called Ireland ed Mekla — Great Ireland, or the

White Man's land. When Pizarro penetrated into the heart of Mexico, a tradition already existed of the previous arrival of white men from the East. Among the Shawnasee Indians a story is still preserved of Florida having been once inhabited by white men, who used iron instruments. In 1658, Sir Erland the Priest had in his possession a chart, even then thought ancient, of "The Land of the White Men, or Hibernia Major, situated opposite Vinland the Good;" and Gaelic philologists pretend to trace a remarkable affinity between many of the American-Indian dialects and the ancient Celtic.

But to return to the "*Foam*." After passing the cape, away we went across the spacious Brieda Fiord, at the rate of nine or ten knots an hour, reeling and bounding at the heels of the steamer, which seemed scarcely to feel how uneven was the surface across which we were speeding. Down dropped Snaefell beneath the sea, and dim before us, clad in evening haze, rose the shadowy steeps of Bardestrand. The north-west division of Iceland consists of one huge peninsula, spread out upon the sea like a human hand, the fingers just reaching over the Arctic circle; while up between them run the gloomy fiords, sometimes to the length of twenty, thirty, and even forty miles. Anything more grand and mysterious than the appearance of their solemn portals, as we passed across from bluff to bluff, it is impossible to conceive. Each might have served as a separate entrance to some poet's hell—so drear and fatal seemed the vista one's eye just caught receding between the endless ranks of precipice and pyramid.

There is something, moreover, particularly mystical in the effect of the grey, dreamy atmosphere of an arctic night through whose uncertain medium mountain and headland loom as impalpable as the frontiers of a demon world; and as I kept gazing at the glimmering peaks, and monstrous crags, and shattered stratifications, heaped up along the coast in cyclopean disorder, I understood how natural it was that the Scandinavian mythology, of whose mysteries the Icelanders were ever the natural guardians and interpreters, should have assumed that broad, massive simplicity which is its most beautiful characteristic. Amid the rugged features of such a country the refinements of Paganism would have been dwarfed into insignificance. How out of place would seem a Jove with his beard in ringlets—a trim Apollo—a sleek Bacchus—an ambrosial Venus—a slim Diana, and all their attendant groups of Oreads and Cupids—amid the ocean mists, and icebound torrents, the flame-scarred mountains, and four months' night—of a land which the opposing forces of heat and cold have selected for a battle-field!

The undeveloped reasoning faculty is prone to attach an undue value and meaning to the forms of things, and the infancy of a nation's mind is always more ready to worship the *manifestations* of a Power, than to look beyond them for a cause. Was it not natural then that these northerners, dwelling in daily communion with this grand Nature, should fancy they could perceive a mysterious and independent energy in her operations; and at last come to confound the moral contest man feels within him, with the physical strife he finds around him; to see in the returning sun—fostering into renewed existence the winter-stifled world—even more than a *type* of that spiritual consciousness which alone can make the dead heart stir; to discover even more than an *analogy* between the reign of cold, darkness, and desolation and the still blanker ruin of a sin perverted soul? But in that iron clime, amid such awful associations, the conflict going on was too terrible—the contending powers too visibly in presence of each other, for the practical, conscientious Norse mind to be content with the puny godships of a Roman Olympus, Nectar, Sensuality, and Inextinguishable Laughter were elements of felicity too mean for the nobler atmosphere of their Walhalla; and to those active temperaments and healthy minds,—invigorated and solemnized by the massive mould of the scenery around them,—Strength, Courage, Endurance, and above all Self-sacrifice naturally seemed more essential attributes of divinity than mere elegance and beauty. And we must remember that whilst the vigorous imagination of the north was delighting itself in creating a stately dreamland, where it strove to blend, in a grand world-picture—always harmonious, though not always consistent—the influences which sustain both the physical and moral system of its universe, an undercurrent of sober Gothic common sense induced it—as a kind of protest against the too material interpretation of the symbolism it had employed—to wind up its religious scheme by sweeping into the chaos of oblivion all the glorious fabric it had evoked, and proclaiming—in the place of the transient gods and perishable heaven of its Asgaard—that One undivided Deity, at whose approach the pillars of Walhalla were to fall, and Odin and his peers to perish, with all the subtle machinery of their existence; while man—himself immortal—was summoned to receive at the hands of the Eternal All-Father the sentence that waited upon his deeds. It is true this purer system belonged only to the early ages. As in the case of every false religion, the symbolism of the Scandinavian mythology lost with each succeeding generation something of its transparency, and at last degenerated into a gross superstition. But traces still remained, even down to the times of Christian ascendency, of the deep, philosophical spirit in which it had been originally conceived; and through its homely imagery there ran a vein of tender humor, such as still characterizes the warm-hearted, laughter-loving northern races. Of this mixture of philosophy and fun, the following story is no bad specimen.[1]

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[1] The story of Thor's journey has been translated from the Edda both by the Howitts and Mr. Thorpe.

Once on a time the two Œsir, Thor, the Thunder god, and his brother Lopt, attended by a servant, determined to go eastward to Jotunheim, the land of the giants, in search of adventures. Crossing over a great water, they came to a desolate plain, at whose further end, tossing and waving in the wind, rose the tree tops of a great forest. After journeying for many hours along its dusty labyrinths, they began to be anxious about a resting-place for the night "At last, Lopt perceived a very spacious house, on one side of which was an entrance, as wide as the house itself; and there they took up their night-quarters. At midnight they perceived a great earthquake; the ground reeled under them and the house shook.

"Then up rose Thor and called to his companions. They sought about, and found a side building to the right, into which they went. Thor placed himself at the door, the rest went and sat down further in, and were very much afraid.

"Thor kept his hammer in his hand, ready to defend them. Then they heard a terrible noise and roaring. As it began to dawn, Thor went out, and saw a man lying in the wood not far from them; he was by no means small, and he slept and snored loudly. Then Thor understood what the noise was which they heard in the night. He buckled on his belt of power, by which he increased his divine strength. At the same instant the man awoke, and rose up. It is said that Thor was so much astonished that he did not dare to slay him with his hammer, but inquired his name. He called himself Skrymer. 'Thy name,' said he, 'I need not ask, for I know that thou art Asar-Thor. But what hast thou done with my glove?'

"Skrymer stooped and took up his glove, and Thor saw that it was the house in which they had passed the night, and that the out-building was the thumb."

Here follow incidents which do not differ widely from certain passages in the history of Jack the Giant Killer. Thor makes three several attempts to knock out the easy-going giant's brains during a slumber, in which he is represented as "snoring outrageously,"—and after each blow of the Thunder god's hammer, Skrymer merely wakes up —strokes his beard—and complains of feeling some trifling inconvenience, such as a dropped acorn on his head, a fallen leaf, or a little moss shaken from the boughs. Finally, he takes leave of them,—points out the way to Utgard Loke's palace, advises them not to give themselves airs at his court,—as unbecoming "such little fellows" as they were, and disappears in the wood; "and"—as the old chronicler slyly adds—"it is not said whether the Œsir wished ever to see him again."

They then journeyed on till noon; till they came to a vast palace, where a multitude of men, of whom the greater number were immensely large, sat on two benches. "After this they advanced into the presence of the king, Utgard Loke, and saluted him. He scarcely deigned to give a look, and said smiling: 'It is late to inquire after true tidings from a great distance; but is it not Thor that I see? Yet you are really bigger than I imagined. What are the exploits that you can perform? For no one is tolerated amongst us who cannot distinguish himself by some art or accomplishment.'

"'Then,' said Lopt, 'I understand an art of which I am prepared to give proof; and that is, that no one here can dispose of his food as I can.' Then answered Utgard Loke: 'Truly this *is* an art, if thou canst achieve it; which we will now see.' He called from the bench a man named Loge to contend with Lopt. They set a trough in the middle of the hall, filled with meat. Lopt placed himself at one end and Loge at the other. Both ate the best they could, and they met in the middle of the trough. Lopt had picked the meat from the bones, but Loge had eaten meat, bones, and trough altogether. All agreed Lopt was beaten. Then asked Utgard Loke what art the young man (Thor's attendant) understood? Thjalfe answered, that he would run a race with any one that Utgard Loke would appoint. There was a very good race ground on a level field. Utgard Loke called a young man named Huge, and bade him run with Thjalfe. Thjalfe runs his best, at three several attempts—according to received Saga customs,—but is of course beaten in the race.

"Then asked Utgard Loke of Thor, what were the feats that he would attempt corresponding to the fame that went abroad of him? Thor answered that he thought he could beat any one at drinking. Utgard Loke said, 'Very good;' and bade his cup-bearer bring out the horn from which his courtiers were accustomed to drink. Immediately appeared the cup-bearer, and placed the horn in Thor's hand. Utgard Loke then said, 'that to empty that horn at one pull was well done; some drained it at twice; but that he was a wretched drinker who could not finish it at the third draught.' Thor looked at the horn, and thought that it was not large, though it was tolerably long. He was very thirsty, lifted it to his mouth, and was very happy at the thought of so good a draught. When he could drink no more, he took the horn from his mouth, and saw, to his astonishment, that there was little less in it than before. Utgard Loke said: 'Well hast thou drunk, yet not much. I should never have believed but that Asar-Thor could have drunk more; however, of this I am confident, thou wilt empty it at the second time.' He drank again; but when he took away the horn from his mouth, it seemed to him that it had sunk less this time than the first; yet the horn might now be carried without spilling.

"Then said Utgard Loke: 'How is this, Thor? If thou dost not reserve thyself purposely for the third draught, thine honor must be lost; how canst thou be regarded as a great man, as the Œsir look upon thee, if thou dost not distinguish thyself in other ways more than thou hast done in this?'

"Then was Thor angry, put the horn to his mouth drank with all his might, and strained himself to the utmost; and when he looked into the horn it was now somewhat lessened. He gave up the horn, and would not drink any more. 'Now,' said Utgard Loke, 'now is it clear that thy strength is not so great as we supposed. Wilt thou try some other game, for we see that thou canst not succeed in this?' Thor answered: 'I will now try something else; but I wonder who, amongst the Œsir, would call that a little drink! What play will you propose?'

"Utgard Loke answered: 'Young men think it mere play to lift my cat from the ground; and I would never have proposed this to Œsir Thor, if I did not perceive that thou art a much less man than I had thought thee! Thereupon sprang an uncommonly great grey cat upon the floor. Thor advanced, took the cat round the body, and lifted it up. The cat bent its back in the same degree as Thor lifted; and when Thor had lifted one of its feet from the ground, and was not able to lift it any higher, said Utgard Loke: 'The game has terminated just as I expected. The cat is very great, and Thor is low and small, compared with the great men who are here with us.'

"Then said Thor: 'Little as you call me, I challenge any one to wrestle with me, for now I am angry.' Utgard Loke answered, looking round upon the benches: 'I see no one here who would not deem it play to wrestle with thee: but let us call hither the old Ella, my nurse; with her shall Thor prove his strength, if he will. She has given many one a fall who appeared far stronger than Thor is.' On this there entered the hall an old woman; and Utgard Loke said she would wrestle with Thor. In short, the contest went so, that the more Thor exerted himself, the firmer she stood; and now began the old woman to exert herself, and Thor to give way, and severe struggles followed. It was not long before Thor was brought down on one knee. Then Utgard Loke stepped forward, bade them cease the struggle, and said that Thor should attempt nothing more at his court. It was now drawing towards night; Utgard Loke showed Thor and his companions their lodging, where they were well accommodated.

"As soon as it was light the next morning, up rose Thor and his companions, dressed themselves, and prepared to set out. Then came Utgard Loke, and ordered the table to be set, where there wanted no good provisions, either meat or drink. When they had breakfasted, they set out on their way. Utgard Loke accompanied them out of the castle; but at parting he asked Thor how the journey had gone off; whether he had found any man more mighty than himself? Thor answered, that the enterprise had brought him much dishonor, it was not to be denied, and that he must esteem himself a man of no account, which much mortified him.

"Utgard Loke replied: 'Now will I tell thee the truth, since thou art out of my castle, where, so long as I live and reign, thou shalt never re-enter; and whither, believe me, thou hadst never come if I had known before what might thou possessest, and that thou wouldst so nearly plunge us into great trouble. False appearances have I created for thee, so that the first time when thou mettest the man in the wood it was I; and when thou wouldst open the provision-sack, I had laced it together with an iron band, so that thou couldst not find the means to undo it. After that thou struckest at me three times with the hammer. The first stroke was the weakest, and it had been my death had it hit me. Thou sawest by my castle a rock, with three deep square holes, of which one was very deep: those were the marks of thy hammer. The rock I placed in the way of the blow, without thy perceiving it.

"'So also in the games, when thou contendedst with my courtiers. When Lopt made his essay, the fact was this: he was very hungry, and ate voraciously; but he who was called Loge, was *fire*, which consumed the trough as well as the meat. And Huge (mind) was my *thought* with which Thjalfe ran a race, and it was impossible for him to match it in speed. When thou drankest from the horn, and thoughtest that its contents grew no less, it was, notwithstanding, a great marvel, such as I never believed could have taken place. The one end of the horn stood in the sea, which thou didst not perceive; and when thou comest to the shore thou wilt see how much the ocean has diminished by what thou hast drunk. *Men will call it the ebb.*

"'Further' said he, 'most remarkable did it seem to me that thou liftedst the cat, and in truth all became terrified when they saw that thou liftedst one of its feet from the ground. For it was no cat, as it seemed unto thee, but the great serpent that lies coiled round the world. Scarcely had he length that his tail and head might reach the earth, and thou liftedst him so high up that it was but a little way to heaven. That was a marvellous wrestling that thou wrestledst with Ella (old age), for never has there been any one, nor shall there ever be, let him approach what great age he will, that Ella shall not overcome.

"'Now we must part, and it is best for us on both sides that you do not often come to me; but if it should so happen, I shall defend my castle with such other arts that you shall not be able to effect anything against me.'

"When Thor heard this discourse he grasped his hammer and lifted it into the air, but as he was about to strike he saw Utgard Loke nowhere. Then he turned back to the castle to destroy it, and he saw only a beautiful and wide plain, but no castle."

So ends the story of Thor's journey to Jotunheim.

It was now just upon the stroke of midnight. Ever since leaving England, as each four-and-twenty hours we climbed up nearer to the pole, the belt of dusk dividing day from day had been growing narrower and narrower, until having nearly reached the Arctic circle, this,—the last night we were to traverse,—had dwindled to a thread of shadow. Only another half-dozen leagues more, and we would stand on the threshold of a four months' day! For the few preceding hours clouds had completely covered the heavens, except where a clear interval of sky, that lay along the northern horizon, promised a glowing stage for the sun's last obsequies. But like the heroes of old he had veiled his face to die, and it was not until he dropped down to the sea that the whole hemisphere overflowed with glory and the gilded pageant concerted for his funeral gathered in slow procession round his grave; reminding one of those tardy honors paid to some great prince of song, who—left during life to languish in a garret—is buried by nobles in Westminster Abbey. A few minutes more the last fiery segment had disappeared beneath the purple horizon, and all was over.

"The king is dead—the king is dead—the king is dead! Long live the king!" And up from the sea that had just entombed his sire, rose the young monarch of a new day; while the courtier clouds, in their ruby robes, turned faces still aglow with the favors of their dead lord, to borrow brighter blazonry from the smile of a new master.

A fairer or a stranger spectacle than the last Arctic sunset cannot well be conceived: Evening and Morning—like kinsmen whose hearts some baseless feud has kept asunder—clasping hands across the shadow of the vanished night.

You must forgive me if sometimes I become a little magniloquent;—for really, amid the grandeur of that fresh primæval world, it was almost impossible to prevent one's imagination from absorbing a dash of the local coloring. We seemed to have suddenly waked up among the colossal scenery of Keats' Hyperion. The pulses of young Titans beat within our veins. Time itself,—no longer frittered down into paltry divisions,—had assumed a more majestic aspect. We had the appetite of giants—was it unnatural we should also adopt "the large utterance of the early gods?"

As the "*Reine Hortense*" could not carry coals sufficient for the entire voyage we had set out upon, it had been arranged that the steamer "*Saxon*" should accompany her as a tender, and the Onunder Fiord, on the north-west coast of the island, had been appointed as the place of rendezvous. Suddenly wheeling round therefore to the right we quitted the open sea, and dived down a long grey lane of water that ran on as far as the eye could reach between two lofty ranges of porphyry and amygdaloid. The conformation of these mountains was most curious: it looked as if the whole district was the effect of some prodigious crystallization, so geometrical was the outline of each particular hill, sometimes rising cube-like, or pentagonal, but more generally built up into a perfect pyramid, with stairs mounting in equal gradations to the summit. Here and there the cone of the pyramid would be shaven off, leaving it flat-topped like a Babylonian altar or Mexican teocalli; and as the sun's level rays,—shooting across above our heads in golden rafters from ridge to ridge,—smote brighter on some loftier peak behind, you might almost fancy you beheld the blaze of sacrificial fires. The peculiar symmetrical appearance of these rocks arises from the fact of their being built up in layers of trap, alternating with Neptunian beds; the disintegrating action of snow and frost on the more exposed strata having gradually carved their sides into flights of terraces.

It is in these Neptunian beds that the famous surturbrand is found, a species of bituminous timber, black and shining like pitch coal; but whether belonging to the common carboniferous system, or formed from ancient drift-wood, is still a point of dispute among the learned. In this neighborhood considerable quantities both of zerlite and chabasite are also found, but, generally speaking, Iceland is less rich in minerals than one would suppose; opal, calcedony, amethyst, malachite, obsidian, agate, and feldspar, being the principal. Of sulphur the supply is inexhaustible.

After steaming down for several hours between these terraced hills, we at last reached the extremity of the fiord, where we found the "*Saxon*" looking like a black sea-dragon coiled up at the bottom of his den. Up fluttered a signal to the mast-head of the corvette, and blowing off her steam, she wore round upon her heel, to watch the effects of her summons. As if roused by the challenge of an intruder, the sleepy monster seemed suddenly to bestir itself, and then pouring out volumes of sulphureous breath, set out with many an angry snort in pursuit of the rash troubler of its solitude. At least, such I am sure, might have been the notion of the poor peasant inhabitants of two or three cottages I saw scattered here and there along the loch, as, startled from their sleep, they listened to the stertorous breathing of the long snake-like ships, and watched them glide past with magic motion along the glassy surface of the water. Of course the novelty and excitement of all we had been witnessing had put sleep and bedtime quite out of our thoughts: but it was already six o'clock in the morning; it would require a considerable time to get out of the fiord, and in a few hours after we should be within the Arctic circle, so that if we were to have any sleep at all—now was the time. Acting on these considerations, we all three turned in; and for the next half-dozen hours I lay dreaming of a great funeral among barren mountains, where white bears in peer's robes were the pall-bearers, and a sea-dragon chief-mourner. When we came on deck again, the northern extremity of Iceland lay leagues away on our starboard quarter, faintly swimming through the haze; up overhead blazed the white sun, and below glittered the level sea, like a pale blue disc netted in silver lace. I seldom remember a brighter day; the thermometer was at 72°, and it really felt more as if we were crossing the line than entering the frigid zone.

Animated by that joyous inspiration which induces them to make a fête of everything, the French officers, it appeared, wished to organize a kind of carnival to inaugurate their arrival in Arctic waters, and by means of a piece of chalk and a huge black board displayed from the hurricane-deck of the "*Reine Hortense*," an inquiry was made as to what suggestion I might have to offer in futherance of this laudable object. With that poverty of invention and love of spirits which characterise my nation, I am obliged to confess that, after deep reflection, I was only able to answer, "Grog." But seeing an extra flag or two was being run up at each masthead of the Frenchman, the lucky idea occurred to me to dress the "*Foam*" in all her colors. The schooner's toilette accomplished, I went on board the "*Reine Hortense*," and you cannot imagine anything more fragile, graceful, or coquettish, than her appearance from the deck of the corvette,—as she curtsied and swayed herself on the bosom of the almost imperceptible swell, or flirted up the water with her curving bows. She really looked like a living little lady.

But from all such complacent reveries I was soon awakened by the sound of a deep voice, proceeding apparently from the very bottom of the sea, which hailed the ship in the most authoritative manner, and imperiously demanded her name, where she was going, whom she carried, and whence she came: to all which questions, a young lieutenant, standing with his hat off at the gangway, politely responded. Apparently satisfied on these points, our invisible interlocutor then announced his intention of coming on board. All the officers of the ship collected on the poop to receive him.

In a few seconds more, amid the din of the most unearthly music, and surrounded by a bevy of hideous monsters, a white-bearded, spectacled personage—clad in bear-skin, with a cocked hat over his left ear—presented himself in the gangway, and handing to the officers of the watch an enormous board, on which was written.

" LE PÈRE ARCTIQUE,"

by way of visiting card,—proceeded to walk aft, and take the sun's altitude with what, as far as I could make out, seemed to be a plumber's wooden triangle. This preliminary operation having been completed, there then began a regular riot all over the ship. The yards were suddenly manned with red devils, black monkeys, and every kind of grotesque monster, while the whole ship's company, officers and men promiscuously mingled, danced the cancan upon deck. In order that the warmth of the day should not make us forget that we had arrived in his dominions, the Arctic father had stationed certain of his familiars in the tops, who at stated intervals flung down showers of hard peas, as typical of *hail*, while the powdering of each other's faces with handfuls of flour could not fail to remind everybody on board that we had reached the latitude of *snow*. At the commencement of this noisy festival I found myself standing on the hurricane deck, next to one of the grave savants attached to the expedition, who seemed to contemplate the antics that were being played at his feet with that sad smile of indulgence with which Wisdom sometimes deigns to commiserate the gaiety of Folly. Suddenly he disappeared from beside me, and the next that I saw or heard of him—he was hard at work pirouetting on the deck below with a red-tailed demon, and exhibiting in his steps a "verve" and a graceful audacity which at Paris would have certainly obtained for him the honors of expulsion at the hands of the municipal authorities. The entertainment of the day concluded with a discourse delivered out of a wind-sail by the chaplain attached to the person of the Père Arctique, which was afterwards washed down by a cauldron full of grog, served out in bumpers to the several actors in this unwonted ceremonial. As the prince had been good enough to invite us to dinner, instead of returning to the schooner I spent the intermediate hour in pacing the quarter-deck with Baron de la Roncière,—the naval commander entrusted with the charge of the expedition. Like all the smartest officers in the French navy, he speaks English beautifully, and I shall ever remember with gratitude the cordiality with which he welcomed me on board his ship, and the thoughtful consideration of his arrangements for the little schooner which he had taken in tow. At five o'clock dinner was announced, and I question if so sumptuous a banquet has ever been served up before in that outlandish part of the world, embellished as it was by selections from the best operas played by the *corps a'orchestre* which had accompanied the Prince from Paris. During the pauses of the music the conversation naturally turned on the strange lands we were about to visit, and the best mode of spifflicating the white bears who were probably already shaking in their snow shoes: but alas! while we were in the very act of exulting in our supremacy over these new domains, the stiffened finger of the Ice king was tracing in frozen characters a "Mene, mene, tekel upharsin" on the plate glass of the cabin windows. During the last half-hour the thermometer had been gradually falling, until it was nearly down to 32° ; a dense penetrating fog enveloped both the vessels—(the "*Saxon*" had long since dropped out of sight), flakes of snow began floating slowly down, and a gelid breeze from the north-west told too plainly that we had reached the frontiers of the solid ice, though we were still a good hundred miles distant from the American shore. Although at any other time the terrible climate we had dived into would have been very depressing, under present circumstances I think the change rather tended to raise our spirits, perhaps because the idea of fog and ice in the month of June seemed so completely to uncockneyfy us. At all events there was no doubt now we had got into *les mers glaciales*, as our French friends called them, and, whatever else might be in store for us, there was sure henceforth to be no lack of novelty and excitement.

By this time it was already well on in the evening, so having agreed with Monsieur de la Roncière on a code of signals in case of fogs, and that a jack hoisted at the mizen of the "*Reine Hortense*," or at the fore of the schooner, should be an intimation of a desire of one or other to cast off, we got into the boat and were dropped down alongside our own ship. Ever since leaving Iceland the steamer had been heading east-north-east by compass, but during the whole of the ensuing night she shaped a south-east course ; the thick mist rendering it unwise to stand on any longer in the direction of the *banquise*, as they call the outer edge of the belt that hems in eastern Greenland. About three A.M. it cleared up a little. By breakfast time the sun reappeared, and we could see five or six miles ahead of the vessel. It was shortly after this, that as I was standing in the main rigging peering out over the smooth blue surface of the sea, a white twinkling point of light suddenly caught my eye about a couple of miles off on the port bow, which a telescope soon resolved into a solitary isle of ice, dancing and dipping in the sunlight. As you may suppose, the news brought everybody upon deck; and when almost immediately afterwards a string of other pieces, glittering like a diamond necklace, hove in sight, the excitement was extreme.

Here at all events was honest blue salt water frozen solid, and when, as we proceeded, the scattered fragments thickened, and passed like silver argosies on either hand, until at last we found ourselves enveloped in an innumerable fleet of bergs,—it seemed as if we could never be weary of admiring a sight so strange and beautiful. It was rather in form and color than in size that these ice islets were remarkable; anything approaching to a real iceberg we neither saw, nor are we likely to see. In fact, the lofty ice mountains that wander like vagrant islands along the coast of America, seldom or never come to the eastward or northward of Cape Farewell. They consist of land ice, and are all generated among bays and straits within Baffin's Bay, and first enter the Atlantic a good deal to the southward of Iceland; whereas the Polar ice, among which we have been knocking about, is field ice and—except when packed one ledge above the other, by great pressure—is comparatively flat. I do not think I saw any pieces that were piled up higher than thirty or thirty-five feet above the sea-level, although at a little distance through the mist they may have loomed much loftier.

In quaintness of form, and in brilliancy of colors, these wonderful masses surpassed everything I had imagined; and we found endless amusement in watching their fantastic procession.

At one time it was a knight on horseback, clad in sapphire mail, a white plume above his casque. Or a cathedral window with shafts of chrysophras, new powdered by a snow-storm. Or a smooth sheer cliff of lapis lazuli; or a Banyan tree, with roots descending from its branches, and a foliage as delicate as the efflorescence of molten metal; or a fairy dragon, that breasted the water in scales of emerald; or anything else that your fancy chose to conjure up. After a little time, the mist again descended on the scene, and dulled each glittering form to a shapeless mass of white; while in spite of all our endeavors to keep upon our northerly course, we were constantly compelled to turn and wind about in every direction—sometimes standing on for several hours at a stretch to the southward and eastward. These perpetual embarrassments became at length very wearying, and in order to relieve the tedium of our progress I requested the Doctor to remove one of my teeth. This he did with the greatest ability—a wrench to starboard,—another to port,—and up it flew through the cabin sky-light.

During the whole of that afternoon and the following night we made but little Northing at all, and the next day the ice seemed more pertinaciously in our way than ever; neither could we relieve the monotony of the hours by conversing with each other on the black boards, as the mist was too thick for us to distinguish from on board one ship anything that was passing on the deck of the other. Notwithstanding the great care and skill with which the steamer threaded her way among the loose floes, it was impossible sometimes to prevent fragments of ice striking us with considerable violence on the bows; and as we lay in bed at night, I confess that until we got accustomed to the noise, it was by no means a pleasant thing to hear the pieces angrily scraping along the ship's sides—within two inches of our ears. On the evening of the fourth day it came on to blow pretty hard, and at midnight it had freshened to half a gale; but by dint of standing well away to the eastward we had succeeded in reaching comparatively open water, and I had gone to bed in great hopes that at all events the breeze would brush off the fog, and enable us to see our way a little more clearly the next morning.

At five o'clock A. M., the officer of the watch jumped down into my cabin, and awoke me with the news—"That the Frenchman was a-saying summat on his black board!" Feeling by the motion that a very high sea must have been knocked up during the night, I began to be afraid that something must have gone wrong with the towing-gear, or that a hawser might have become entangled in the corvette's screw—which was the catastrophe of which I had always been most apprehensive; so slipping on a pair of fur boots, which I carefully kept by the bedside in case of an emergency, and throwing a cloak over—

> "Le simple appareil
> D'une beauté qu'on vient d'arracher au sommeil,"

I caught hold of a telescope, and tumbled up on deck. Anything more bitter and disagreeable than the icy blast, which caught me round the waist as I emerged from the companion I never remember. With both hands occupied in levelling the telescope, I could not keep the wind from blowing the loose wrap quite off my shoulders, and except for the name of the thing, I might just as well have been standing in my shirt. Indeed, I was so irresistibly struck with my own resemblance to a colored print I remember in youthful days, — representing that celebrated character "Puss in Boots," with a purple robe of honor streaming far behind him on the wind, to express the velocity of his magical progress—that I laughed aloud while I shivered in the blast. What with the spray and mist, moreover, it was a good ten minutes before I could make out the writing, and when at last I did spell out the letters, their meaning was not very inspiriting: "*Nous retournons à Reykjavik!*" So evidently they had given it up as a bad job, and had come to the conclusion that the island was inaccessible. Yet it seemed very hard to have to turn back, after coming so far! We had already made upwards of 300 miles since leaving Iceland: it could not be much above 120 or 130 more to Jan Mayen; and although things looked unpromising, there still seemed such a chance of success, that I could not find it in my heart to give in; so, having run up a jack at the fore—all writing on our board was out of the question, we were so deluged with spray—I jumped down to wake Fitzgerald and Sigurdr, and tell them we were going to cast off, in case they had any letters to send home. In the mean time, I scribbled a line of thanks and good wishes to M. de la Roncière, and another to you, and guyed it with our mails on board the corvette—in a milk can.

In the mean time all was bustle on board our decks and I think every one was heartily pleased at the thoughts of getting the little schooner again under canvass. A couple of reefs were hauled down in the mainsail and staysail, and everything got ready for making sail.

"Is all clear for'ard for slipping, Mr. Wyse?"

"Ay, ay, Sir; all clear!"

"Let go the tow-ropes!"

"All gone, Sir!"

And down went the heavy hawsers into the sea, up fluttered the staysail,—then—poising for a moment on the waves with the startled hesitation of a bird suddenly set free,—the little creature spread her wings, thrice dipped her ensign in token of adieu—receiving in return a hearty cheer from the French crew—and glided like a phantom into the North, while the "*Reine Hortense*" puffed back to Iceland.[1]

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[1] It subsequently appeared that the "*Saxon*," on the second day after leaving Onunder Fiord, had unfortunately knocked a hole in her bottom against the ice, and was obliged to run ashore in a sinking state. In consequence of never having been rejoined by her tender, the "*Reine Hortense*" found herself short of coals; and as the en-

Ten minutes more, and we were the only denizens of that misty sea. I confess I felt excessively sorry to have lost the society of such joyous companions; they had received us always with such merry good nature: the Prince had shown himself so gracious and considerate, and he was surrounded by a staff of such clever, well-informed persons, that it was with the deepest regret I watched the fog close round the magnificent corvette, and bury her—and all whom she contained—within its bosom. Our own situation, too, was not altogether without causing me a little anxiety. We had not seen the sun for two days; it was very thick with a heavy sea, and dodging about as we had been among the ice, at the heels of the steamer, our dead reckoning was not very much to be depended upon. The best plan I thought would be to stretch away at once clear of the ice, then run up into the latitude of Jan Mayen, and—as soon as we should have reached the parallel of its northern extremity—bear down on the land. If there was any access at all to the island, it was very evident it would be on its northern or eastern side; and now that we were alone, to keep on knocking up through a hundred miles or so of ice in a thick fog, in our fragile schooner, would have been out of the question.

The ship's course, therefore, having been shaped in accordance with this view, I stole back into bed and resumed my violated slumbers. Towards mid-day the weather began to moderate, and by four o'clock we were skimming along on a smooth sea, with all sails set. This state of prosperity continued for the next twenty-four hours; we had made about eighty knots since parting company with

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cumbered state of the sea rendered it already very unlikely that any access would be found open to the island, M. de la Roncière very properly judged it advisable to turn back. He re-entered the Reykjavik harbor without so much as a shovelful of coals left on board.

the Frenchman, and it was now time to run down West and pick up the land. Luckily the sky was pretty clear, and as we sailed on through open water I really began to think our prospects very brilliant. But about three o'clock on the second day, specks of ice began to flicker here and there on the horizon, then larger bulks came floating by in forms as picturesque as ever—(one, I particularly remember, a human hand thrust up out of the water with outstretched forefinger, as if to warn us against proceeding farther), until at last the whole sea became clouded with hummocks that seemed to gather on our path in magical multiplicity.

Up to this time we had seen nothing of the island, yet I knew we must be within a very few miles of it; and now to make things quite pleasant, there descended upon us a thicker fog than I should have thought the atmosphere capable of sustaining; it seemed to hang in solid festoons from the masts and spars. To say that you could not see your hand, ceased almost to be any longer figurative even the ice was hid—except those fragments immediately adjacent, whose ghastly brilliancy the mist itself could not quite extinguish, as they glimmered round the vessel like a circle of luminous phantoms. The perfect stillness of the sea and sky added very much to the solemnity of the scene; almost every breath of wind had fallen, scarcely a ripple tinkled against the copper sheathing, as the solitary little schooner glided along at the rate of half a knot or so an hour, and the only sound we heard was the distant wash of waters, but whether on a great shore, or along a belt of solid ice, it was impossible to say. In such weather,—as the original discoverers of Jan Mayen said under similar circumstances,—"it was easier to hear land than to see it." Thus, hour after hour passed by and brought no change. Fitz and Sigurdr—who had begun quite to disbelieve in the existence of the island—went to bed, while I remained pacing up and down the deck, anxiously questioning each quarter of the grey canopy that enveloped us. At last, about four in the morning, I fanced some change was going to take place; the heavy wreaths of vapor seemed to be imperceptibly separating, and in a few minutes more the solid roof of grey suddenly split asunder, and I beheld through the gap—thousands of feet overhead, as if suspended in the crystal sky—a cone of illuminated snow.

You can imagine my delight. It was really that of an anchorite catching a glimpse of the seventh heaven. There at last was the long-sought-for mountain actually tumbling down upon our heads. Columbus could not have been more pleased when, after nights of watching, he saw the first fires of a new hemisphere dance upon the water; nor indeed, scarcely less disappointed at their sudden disappearance than I was, when, after having gone below to wake Sigurdr, and tell him we had seen bona fide terra-firma, I found, on returning upon deck, that the roof of mist had closed again, and shut out all trace of the transient vision. However I had got a clutch of the Island, and no slight matter should make me let go my hold. In the meantime there was nothing for it but to wait patiently until the curtain lifted; and no child ever stared more eagerly at a green drop-scene in expectation of "the realm of dazzling splendor" promised in the bill, than I did at the motionless grey folds that hung round us. At last the hour of liberation came; a purer light seemed gradually to penetrate the atmosphere, brown turned to grey, and grey to white, and white to transparent blue, until the lost horizon entirely reappeared except where in one direction an impenetrable veil of haze still hung suspended from the zenith to the sea. Behind that veil I knew must lie Jan Mayen.

A few minutes more, and slowly, silently, in a manner you could take no count of, its dusky hem first deepened to a violet tinge, then gradually lifting, displayed a long line of coast—in reality but the roots of Beerenberg—dyed of the darkest purple; while obedient to a common impulse, the clouds that wrapped its summit gently disengaged themselves, and left the mountain standing in all the magnificence of his 6,870 feet, girdled by a single zone of pearly vapor, from underneath whose floating folds seven enormous glaciers rolled down into the sea! Nature seemed to have turned scene-shifter, so artfully were the phases of this glorious spectacle successively developed.

Although—by reason of our having hit upon its side instead of its narrow end—the outline of Mount Beerenberg appeared to us more like a sugar-loaf than a spire—broader at the base and rounder at the top than I had imagined,—in size, color, and effect, it far surpassed anything I had anticipated. The glaciers were quite an unexpected element of beauty. Imagine a mighty river of as great a volume as the Thames—started down the side of a mountain,—bursting over every impediment,—whirled into a thousand eddies,—tumbling and raging on from ledge to ledge in quivering cataracts of foam,—then suddenly struck rigid by a power so instantaneous in its action that even the froth and fleeting wreaths of spray have stiffened into the immutability of sculpture. Unless you had seen it, it would be almost impossible to conceive the strangeness of the contrast between the actual tranquillity of these silent crystal rivers and the violent descending energy impressed upon their exterior. You must remember, too, all this is upon a scale of such prodigious magnitude, that when we succeeded subsequently in approaching the spot—where with a leap like that of Niagara one of these glaciers plunges down into the sea—the eye, no longer able to take in its fluvial character, was content to rest in simple astonishment at what then appeared a lucent precipice of grey-green ice, rising to the height of several hundred feet above the masts of the vessel.

As soon as we had got a little over our first feelings of astonishment at the panorama thus suddenly revealed to us by the lifting of the fog, I began to consider what would be the best way of getting to the anchorage on the west—or Greenland side of the island. We were still seven or eight miles from the shore, and the northern extremity of the island, round which we should have to pass, lay about five leagues off, bearing West by North, while between us and the land stretched a continuous breadth of floating ice. The hummocks, however, seemed to be pretty loose with openings here and there, so that with careful sailing I thought we might pass through, and perhaps on the farther side of the island come into a freer sea. Alas! after having with some difficulty wound along until we were almost abreast of the cape, we were stopped dead short by a solid rampart of fixed ice, which in one direction leant upon the land, and in the other ran away as far as the eye could reach into the dusky North. Thus hopelessly cut off from all access to the western and better anchorage, it only remained to put about, and—running down along the land—attempt to reach a kind of open roadstead on the eastern side, a little to the south of the volcano described by Dr. Scoresby: but in this endeavor also we were doomed to be disappointed; for after sailing some considerable distance through a field of ice, which kept getting more closely packed as we pushed further into it, we came upon another barrier equally impenetrable, that stretched away from the island toward the Southward and Eastward. Under these circumstances, the only thing to be done was to get back to where the ice was looser, and attempt a landing wherever a favorable opening presented itself. But even to extricate ourselves from our present position, was now no longer of such easy performance. Within the last hour the wind had shifted into the North-West; that is to say, it was now blowing right down the path along which we had picked our way; in order to return, therefore, it would be necessary to work the ship to windward through a sea as thickly crammed with ice as a lady's boudoir is with furniture. Moreover, it had become evident, from the obvious closing of the open spaces, that some considerable pressure was acting upon the outside of the field; but whether originating in a current, or the change of wind, or another field being driven down upon it, I could not tell. Be that as it might, out we must get,—unless we wanted to be cracked like a walnut-shell between the drifting ice and the solid belt to leeward; so sending a steady hand to the helm,—for these unusual phenomena had begun to make some of my people lose their heads a little, no one on board having ever seen a bit of ice before,—I stationed myself in the bows, while Mr. Wyse conned the vessel from the square yard. Then there began one of the prettiest and most exciting pieces of nautical manœuvring that can be imagined. Every single soul on board was summoned upon deck; to all, their several stations and duties were assigned—always excepting the cook, who was merely directed to make himself generally useful. As soon as everybody was ready, down went the helm,—about came the ship,—and the critical part of the business commenced. Of course, in order to wind and twist the schooner in and out among the devious channels left between the hummocks, it was necessary she should have considerable way on her; at the same time so narrow were some of the passages, and so sharp their turnings, that unless she had been the most handy vessel in the world, she would have had a very narrow squeak for it. I never saw anything so beautiful as her behavior. Had she been a living creature, she could not have dodged, and wound, and doubled, with more conscious cunning and dexterity; and it was quite amusing to hear the endearing way in which the people spoke to her, each time the nimble creature contrived to elude some more than usually threatening tongue of ice. Once or twice in spite of all our exertions, it was impossible to save her from a collision; all that remained to be done, as it became evident she could not clear some particular floe, or go about in time to avoid it, was to haul the staysail sheet a-weather in order to deaden her way as much as possible, and putting the helm down—let her go right at it, so that she should receive the blow on her stem, and not on the bluff of the bow; while all hands, armed with spars and fenders, rushed forward to ease off the shock. And here I feel it just to pay a tribute of admiration to the cook, who on these occasions never failed to exhibit an immense amount of misdirected energy, breaking—I remember—at the same moment, both the cabin sky-light, and an oar, in single combat with a large berg that was doing no particular harm, to us, but against which he seemed suddenly to have conceived a violent spite. Luckily a considerable quantity of snow overlaid the ice, which, acting as a buffer in some measure mitigated the violence of the concussion while the very fragility of her build diminishing the momentum, proved in the end the little schooner's greatest security. Nevertheless, I must confess that more than once, while leaning forward in expectation of the *scrunch* I knew must come, I have caught myself half murmuring to the fair face that seemed to gaze so serenely at the cold white mass we were approaching: "O Lady, is it not now fit thou shouldest befriend the good ship of which thou art the pride?"

At last after having received two or three pretty severe bumps,—though the loss of a little copper was the only damage they entailed,—we made our way back to the northern end of the island, where the pack was looser, and we had at all events a little more breathing room.

It had become very cold;—so cold, indeed, that Mr. Wyse—no longer able to keep a clutch of the rigging—had a severe tumble from the yard on which he was standing. The wind was freshening, and the ice was evidently still in motion; but although very anxious to get back again into open water, we thought it would not do to go away without landing, even if it were only for an hour. So having laid the schooner right under the cliff, and putting into the gig our own discarded figure-head, a white ensign, a flag staff, and a tin biscuit-box, containing a paper on which I had hastily written the schooner's name, the date of her arrival and the names of all those who sailed on board,—we pulled ashore. A ribbon of beach not more than fifteen yards wide, composed of iron-sand, augite, and pyroxene, running along under the basaltic precipice—upwards of a thousand feet high—which serves as a kind of plinth to the mountain, was the only standing room this part of the coast afforded. With considerable difficulty, and after a good hour's climb we succeeded in dragging the figure-head we had brought ashore with us, up a sloping patch of snow, which lay in a crevice of the cliff, and thence a little higher, to a natural pedestal formed by a broken shaft of rock; where—after having tied the tin box round her neck, and duly planted the white ensign of St. George beside her,—we left the superseded damsel, somewhat grimly smiling across the frozen ocean at her feet, until some Bacchus of a bear should come to relieve the loneliness of my wooden Ariadne.

On descending to the water's edge, we walked some little distance along the beach without observing anything very remarkable, unless it were the network of vertical and horizontal dikes of basalt which shot in every direction through the scoriæ and conglomerate of which the cliff seemed to be composed. Innumerable sea-birds sat in the crevices and ledges of the uneven surface, or flew about us with such confiding curiosity, that by reaching out my hand I could touch their wings as they poised themselves in the air alongside. There was one old sober-sides with whom I passed a good ten minutes *tête-à-tête*, trying who could stare the other out of countenance.

It was now high time to be off. As soon then as we had collected some geological specimens, and duly christened the little cove, at the bottom of which we had landed, "Clandeboye Creek,"—we walked back to the gig. But—so rapidly was the ice drifting down upon the island,—we found it had already become doubtful whether we should not have to carry the boat over the patch which—during the couple of hours we had spent on shore—had almost cut her off from access to the water. If this was the case with the gig, it was very evident the quicker we got the schooner out to sea again the better. So immediately we returned on board, having first fired a gun in token of adieu to the desolate land we should never again set foot on, the ship was put about, and our task of working out towards the open water recommenced. As this operation was likely to require some time, directly breakfast was over, (it was now about eleven o'clock A.M.,) and after a vain attempt had been made to take a photograph of the mountain, which the mist was again beginning to envelope, I turned in to take a nap, which I rather needed,—fully expecting that by the time I awoke we should be beginning to get pretty clear of the pack. On coming on deck, however, four hours later, although we had reached away a considerable distance from the land, and had even passed the spot, where, the day before, the sea was almost free,—the floes seemed closer than ever; and, what was worse, from the mast-head not a vestige of open water was to be discovered. On every side, as far as the eye could reach, there stretched over the sea one cold white canopy of ice.

The prospect of being beset, in so slightly built a craft, was—to say the least—unpleasant; it looked very much as if fresh packs were driving down upon us from the very direction in which we were trying to push out, yet it had become a matter of doubt which course it would be best to steer. To remain stationary was out of the question; the pace at which the fields drift, is sometimes very rapid,[1] and the first nip would settle the poor little schooner's business for ever. At the same time, it was quite possible that any progress we succeeded in making, instead of tending towards her liberation, might perhaps be only getting her deeper into the scrape. One thing was very certain,—Northing or Southing might be an even chance, but whatever *Easting* we could make must be to the good; so I determined to choose whichever vein seemed to have most Easterly direction in it. Two or three openings of this sort from time to time presented themselves; but in every case, after following them a certain distance, they proved to be but *cul-de-sacs*, and we had to return discomfited. My great hope was in a change of wind. It was already blowing very fresh from the northward and eastward; and if it would but shift a few points, in all probability the ice would loosen as rapidly as it had collected. In the mean time, the only thing to do was to keep a sharp look-out, sail the vessel carefully, and take advantage of every chance of getting to the eastward.

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[1] Dr. Scoresby states that the invariable tendency of fields of ice is to drift south-westward, and that the strange effects produced by their occasional rapid motions, is one of the most striking objects the Polar Seas present, and certainly the most terrific. They frequently acquire a rotary motion, whereby their circumference attains a velocity of several miles an hour; and it is scarcely possible to conceive the consequences produced by a body, exceeding ten thousand million tons in weight, coming in contact with another under such circumstances. The strongest ship is but an insignificant impediment between two fields in motion Numbers of whale vessels have thus been destroyed; some have been thrown upon the ice; some have had their hulls completely torn open, or divided in two, and others have been overrun by the ice, and buried beneath its heaped fragments.

It now grew colder than ever,—the distant land was almost hid with fog,—tattered dingy clouds came crowding over the heavens,—while Wilson moved uneasily about the deck, with the air of Cassandra at the conflagration of Troy. It was Sunday, the 14th of July, and I had a momentary fancy that I could hear the sweet church bells in England pealing across the cold white flats which surrounded us. At last, about five o'clock P. M., the wind shifted a point or two, then flew round into the south-east. Not long after, just as I had expected, the ice evidently began to loosen,—a promising opening was reported from the mast-head, a mile or so away on the port-bow, and by nine o'clock we were spanking along, at the rate of eight knots an hour, under a double-reefed mainsail and staysail —down a continually widening channel, between two wave-lashed ridges of drift ice. Before midnight, we had regained the open sea, and were standing away

"To Norroway,
To Norroway over the faem."

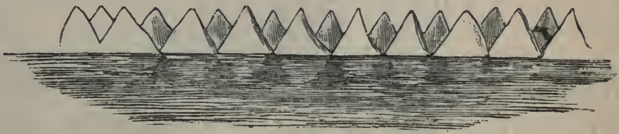
In the forenoon I had been too busy to have our usual Sunday church; but as soon as we were pretty clear of the ice I managed to have a short service in the cabin.

Of our run to Hammerfest I have nothing particular to say. The distance is eight hundred miles, and we did it in eight days. On the whole, the weather was pretty fair, though cold, and often foggy. One day indeed was perfectly lovely,—the one before we made the coast of Lapland,—without a cloud to be seen for the space of twenty-four hours; giving me an opportunity of watching the sun performing his complete circle overhead, and taking a me-

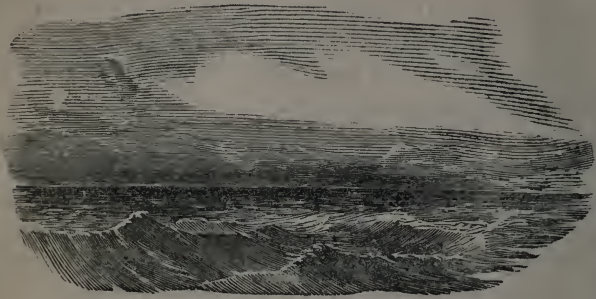
TAKING A SIGHT.

ridian altitude at midnight. We were then in 70° 25′ North latitude; *i. e.*, almost as far north as the North Cape; yet the thermometer had been up to 80° during the afternoon.

Shortly afterwards the fog came on again, and next morning it was blowing very hard from the eastward. This was the more disagreeable, as it is always very difficult, under the most favorable circumstances, to find one's way into any harbor along this coast, fenced off, as it is, from the ocean by a complicated outwork of lofty islands, which in their turn, are hemmed in by nests of sunken rock, sown as thick as peas, for miles to seaward. There are no pilots until you are within the islands, and no longer want them, —no light-houses or beacons of any sort; and all that you have to go by is the shape of the hill-tops; but as, on the clearest day, the outline of the mountains have about as much variety as the teeth of a saw, and as on a cloudy day, which happens about seven times a week, you see nothing but the line of their dark roots,—the unfortunate mariner, who goes poking about for the narrow passage which is to lead him between the islands,—at the *back* of one of which a pilot is waiting for him,—will, in all probability, have already placed his vessel in a position to render that functionary's further attendance a work of supererogation. At least, I know it was as much surprise as pleasure that I experienced, when, after having with many misgivings ventured to slip through an opening in the monotonous barricade of mountains, we found it was the right channel to our port. If the king of all the Goths would only stick up a light-house here and there along the edge of his



Arctic seaboard, he would save many an honest fellow a heart-ache.



I must now finish this long letter.

Hammerfest is scarcely worthy of my wasting paper on it. When I tell you that it is the most northerly town in Europe, I think I have mentioned its only remarkable characteristic. It stands on the edge of an enormous sheet of water, completely landlocked by three islands, and consists of a congregation of wooden houses, plastered up against a steep mountain; some of which being built on piles, give the notion of the place having slipped down off the hill half-way into the sea. Its population is so and so,—its chief exports this and that; for all which, see Mr. Murray's "Handbook," where you will find all such matters much more clearly and correctly set down than I am likely to state them. At all events, it produces milk, cream—*not* butter—salad, and bad potatoes; which is what we are most interested in at present. To think that you should be all revelling this very moment in green-peas and cauliflowers. I hope you don't forget your grace before dinner.

I will write to you again before setting sail for Spitzbergen.

FIRST GLIMPSE OF JAN MAYEN.

LETTER IX.

EXTRACT FROM THE "MONITEUR" OF THE 31ST JULY.

I HAVE received a copy of the "Moniteur" of the 31st July, containing so graphic an account of the voyage of the "*Reine Hortense*," towards Jan Mayen, and of the catastrophe to her tender the "*Saxon*,"—in consequence of which the corvette was compelled to abandon her voyage to the Northward,—that I must forward it to you.

(*Translation.*)

"*Voyage of Discovery along the Banquise, north of Iceland, by* 'LA REINE HORTENSE.'

"It fell to the lot of an officer of the French navy, M. Jules de Blosseville, to attempt to explore those distant parts, and to shed an interest over them, both by his discoveries and by his tragical and premature end.

"In the spring of 1833, on the breaking up of a frost, '*La Lilloise*,' under the command of that brave officer, succeeded in passing through the *Banquise*, nearly up to latitude 69°, and in surveying about thirty leagues of coast to the south of that latitude. After having returned to her anchorage off the coast of Iceland, he sailed again in July for a second attempt. From that time nothing has been heard of '*La Lilloise*.'

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"The following year the '*Bordelaise*' was sent to look for the '*Lilloise*,' but found the whole north of Iceland blocked up by ice-fields; and returned, having been stopped in the latitude of the North Cape.

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As a voyage to the Danish colonies on the western coast of Greenland formed part of the scheme of our arctic navigation, we were aware at our departure from Paris, that it was our business to make ourselves well acquainted with the southern part of the ice-field, from Reykjavik to Cape Farewell. But while we were touching at Peterhead, the principal port for the fitting of vessels destined for the seal fishery, the Prince, and M. de la Roncière, Commander of '*La Reine Hortense*,' gathered—from conversations with the fishermen just returned from their spring expedition—some important information on the actual state of the ice. They learnt from them that navigation was completely free this year round the whole of Iceland; that the ice-field resting on Jan Mayen Island, and surrounding it to a distance of about twenty leagues, extended down the south-west along the coast of Greenland, but without blocking up the channel which separates that coast from that of Iceland. These unhoped-for circumstances opened a new field to our explorations, by allowing us to survey all that part of the *Banquise* which extends to the north of Iceland, thus forming a continuation to the observations made by the '*Recherche*,' and to those which we ourselves intended to make during our voyage to Greenland. The temptation was too great for the Prince; and Commander de la Roncière was not a man to allow an opportunity to escape for executing a project which presented itself to him with the character of daring and novelty.

But the difficulties of the enterprise were serious and of such a nature that no one but a sailor experienced in navigation is capable of appreciating. The '*Reine Hortense*' is a charming pleasure-boat, but she offers very few of the requisites for a long voyage, and she was destitute of all the special equipment indispensable for a long sojourn in the ice. There was room but for six days' coals, and for three weeks' water. As to the sails, one may say the masts of the corvette are merely for show, and that without steam it would be impossible to reckon on her making any way regularly and uninterruptedly. Add to this, that she is built of iron,—that is to say, an iron sheet of about two centimètres thick constitutes all her planking,—and that her deck—divided into twelve great panels, is so weak that it has been thought incapable of carrying guns proportioned to her tonnage. Those who have seen the massive vessels of the fishermen of Peterhead, their enormous outside planking, their bracings and fastenings in wood and in iron, and their internal knees and stancheons may form an idea from such precautions—imposed by long experience of the nature of the dangers that the shock—or even the pressure of the ice—may cause to a ship in the latitudes that we were going to explore.

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The '*Cocyte*' had also been placed at the disposal of H. I. H. Prince Napoleon. This vessel which arrived at Reykjavik the same day that we did, the 30th of June—is a steam schooner, with paddles, standing the sea well, carrying coals for twelve days, but with a deplorably slow rate of speed.

We found besides at Reykjavik the war transport '*La Perdrix*' and two English merchant steamers, the '*Tasmania*' and the '*Saxon*,' freighted by the Admiralty to take to Iceland coals necessary for our voyage to Greenland. These five vessels, with the frigate '*Artemise*,' which performed the duties of guardship, formed the largest squadron which had ever assembled in the harbor of the capital of Iceland.

Unfortunately, these varied and numerous elements had nothing in common, and Commodore de la Roncière soon saw that extraneous help would afford us no additional security; and, in short, that the '*Reine Hortense*'—obliged to go fast—as her short supplies would not allow long voyages, had to reckon on herself alone. However, the [English] captain of the '*Saxon*' expressing a great desire to visit these northern parts, and displaying on this subject a sort of national vanity, besides promising an average speed of seven knots an hour, it was decided that —at all events, that vessel should start alone with the '*Reine Hortense*,' whose supply of coals it would be able to replenish, in the event—a doubtful one, it is true—of our making the coast of Jan Mayen's Island, and finding a good anchorage. The '*Reine Hortense*,' had—by the help of a supplementary load on deck—a supply of coals for eight days; and immediately on starting, the crew as well as the passengers, were to be put on a measured allowance of water.

A few hours before getting under way, the expedition was completed by the junction of a new companion, quite unexpected. We found in Reykjavik harbor a yacht belonging to Lord Dufferin. The Prince, seeing his great desire to visit the neighborhood of Jay Mayen, offered to take his schooner in tow of the '*Reine Hortense*.' It was a fortunate accident for a seeker of maritime adventures; and an hour afterwards, the proposition having been eagerly accepted, the Englishman was attached by two long cables to the stern of our corvette.

On the 7th of July, 1856, at two o'clock in the morning, after a ball given by Commander de Mas on board the '*Artemise*,'—the '*Reine Hortense*,' with the English schooner in tow, left Reykjavik harbor, directing her course along the west coast of Iceland, towards Onundarfiord, where we were to join the '*Saxon*' which had left a few hours before us. At nine o'clock, the three vessels, steering east-north-east, doubled the point of Cape North. At noon our observation of the latitude placed us about 67°. We had just crossed the Arctic circle. The temperature was that of a fine spring day, 10° centigrade (50° Farenh.).

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The '*Reine Hortense*' diminished her speed. A rope thrown across one of the towing-ropes enabled Lord Dufferin to haul one of his boats to our corvette. He himself came to dine with us, and to be present at the ceremony of crossing the polar circle. As to the '*Saxon*,' M. de la Roncière perceived by this time that the worthy Englishman had presumed too much on his power. The '*Saxon*' was evidently incapable of following us. The captain, therefore, made her signal that she was to take her own course, to try and reach Jan Mayen; and if she could not succeed, to direct her course on Onundarfiord, and there to wait for us. The English vessel fell rapidly astern, her hull disappeared, then her sails, and in the evening every trace of her smoke had faded from the horizon.

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In the evening, the temperature grew gradually colder; that of the water underwent a more rapid and significant change. At twelve at night it was only three degrees centig. (about 37° Fahr.). At that moment the vessel plunged into a bank of fog, the intensity of which we were enabled to ascertain, from the continuance of daylight in these latitudes at this time of the year. There are tokens that leave no room to doubt that we are approaching the solid ice. True enough:—at two o'clock in the morning the officer on watch sees close to the ship a herd of seals, inhabitants of the field ice. A few minutes later the fog clears up suddenly; a ray of sunshine gilds the surface of the sea, lighting up millions of patches of sparkling white, extending to the farthest limit of the horizon. These are the detached hummocks which precede and announce the field ice; they increase in size and in number as we proceed, At three o'clock in the afternoon we find ourselves in front of a large pack which blocks up the sea before us. We are obliged to change our course to extricate ourselves from the ice that surrounds us.

This is an evolution requiring on the part of the commander the greatest precision of eye, and a perfect knowledge of his ship. The '*Reine Hortense*,' going half speed, with all the officers and the crew on deck, glides along between the blocks of ice, some of which she seems almost to touch, and the smallest of which would sink her instantly if a collision took place. Another danger, which it is almost impossible to guard against, threatens a vessel in those trying moments. If a piece of ice gets under the screw, it will be inevitably smashed like glass, and the consequences of such an accident might be fatal.

The little English schooner follows us bravely; bounding in our track, and avoiding only by a constant watchfulness and incessant attention to the helm the icebergs that we have cleared.

But the difficulties of this navigation are nothing in clear weather, as compared to what they are in a fog. Then, notwithstanding the slowness of the speed, it requires as much luck as skill to avoid collisions. Thus it happened that after having escaped the ice a first time, and having steered E.N.E., we found ourselves suddenly, towards two o'clock of that same day (the 9th), not further than a quarter of a mile from the field ice which the fog had hidden from us. Generally speaking, the *Banquise* that we coasted along for three days, and that we traced with the greatest care for nearly a hundred leagues, presented to us an irregular line of margin, running from W.S.W. to E.N.E., and thrusting forward toward the south —capes and promontories of various sizes, and serrated like the teeth of a saw. Every time that we bore up for E.N.E., we soon found ourselves in one of the gulfs of ice formed by the indentations of the *Banquise.* It was only by steering to the S.W. that we got free from the floating icebergs, to resume our former course as soon as the sea was clear.

The further we advanced to the northward, the thicker became the fog and more intense the cold (two degrees centig. below zero); and snow whirled round in squalls of wind, and fell in large flakes on the deck. The ice began to present a new aspect, and to assume those fantastic and terrible forms and colors, which painters have made familiar to us. At one time it assumed the appearance of mountain-peaks covered with snow, furrowed with valleys of green and blue; more frequently they appeared like a wide flat plateau, as high as the ship's deck, against which the sea rolled with fury, hollowing its edges into gulfs, or breaking them into perpendicular cliffs or caverns, into which the sea rushed in clouds of foam.

We often passed close by a herd of seals, which—stretched on these floating islands, followed the ship with a stupid and puzzled look. We were forcibly struck with the contrast between the ficticious world in which we lived on board the ship, and the terrible realities of nature that surrounded us. Lounging in an elegant saloon, at the corner of a clear and sparkling fire, amidst a thousand objects of the arts and luxuries of home, we might have believed that we had not changed our residence, or our habits, or our enjoyments. One of Strauss's waltzes, or Schubert's melodies—played on the piano by the bandmaster—completed the illusion; and yet we had only to rub off the thin incrustation of frozen vapor that covered the panes of the windows, to look out upon the gigantic and terrible forms of the icebergs dashed against each other by a black and broken sea, and the whole panorama of Polar nature, its awful risks, and its sinister splendors.

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Meanwhile, we progressed but very slowly. On the 10th of July we were still far from the meridian of Jan Mayen, when we suddenly found ourselves surrounded by a fog, and at the bottom of one of the bays formed by the field of ice. We tacked immediately, and put the ship about, but the wind had accumulated the ice behind us. At a distance the circle that enclosed us seemed compact and without egress. We considered this as the most critical moment of our expedition. Having tried this icy barrier at several points, we found a narrow and tortuous channel, into which we ventured; and it was not till after an hour of anxieties that we got a view of the open sea, and of a passage into it. From this moment we were able to coast along the *Banquise* without interruption.

On the 11th of July at 6 A. M. we reached, at last, the meridian of Jay Mayen, at about eighteen leagues'[1] distance from the southern part of that island, but we saw the ice-field stretching out before us as far as the eye could reach; hence it became evident that Jan Mayen was blocked up by the ice, at least along its south coast. To ascertain whether it might still be accessible from the north, it would have been necessary to have attempted a circuit to the eastward, the possible extent of which could not be estimated; moreover, we had consumed half our coals, and had lost all hope of being rejoined by the '*Saxon*.' Thus forced to give up any further attempt in that direction, Commodore de la Roncière, having got the ship clear of the floating ice, took a W.S.W. course, in the direction of Reykjavik.

The instant the '*Reine Hortense*' assumed this new course, a telegraphic signal—as had been previously arranged—acquainted Lord Dufferin with our determinations. Almost immediately, the young Lord sent on board us a tin box, with two letters, one for his mother, and one for our commander. In the latter he stated that—finding himself clear of the ice, and master of his own movements—he preferred continuing his voyage alone, uncertain whether he should at once push for Norway, or return to Scotland.[1] The two ropes that united the vessels were then cast off, a farewell hurrah was given, and in a moment the English schooner was lost in the fog.

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[1] I think there must be some mistake here; when we parted company with the "*Reine Hortense*," we were still upward of 100 miles distant from the southern extremity of Jan Mayen.

Our return to Reykjavik afforded no incident worth notice; the '*Reine Hortense*' keeping her course outside the ice, encountered no impediment, except from the intense fogs, which forced her—from the impossibility of ascertaining her position—to lie to, and anchor off the cape during part of the day and night of the 13th.

On the morning of the 14th, as we were getting out at the Dyre Fiord, where we had anchored, we met—to our great astonishment—the '*Cocyte*' proceeding northward. Her commander, Sonnart, informed us that on the evening of the 12th, the '*Saxon*'—in consequence of the injuries she had received, had been forced back to Reykjavik. She had hardly reached the ice on the 9th, when she came into collision with it; five of her timbers had been stove in, and an enormous leak had followed. Becoming waterlogged, she was run ashore, the first time at Onundarfiord, and again in Reykjavik roads, whither she had been brought with the greatest difficulty."

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[1] I was purposely vague as to my plans, lest you might learn we still intended to go on.

LETTER X.

BUCOLICS—THE GOAT—MAID MARIAN—A LAPP LADY—LAPP LOVE-MAKING—THE SEA-HORSEMAN—THE GULF STREAM—ARCTIC CURRENTS—A DINGY EXPEDITION—A SCHOOL OF PERIPATETIC FISHES—ALTEN—THE CHÂTELAINE OF KAAFIORD—STILL NORTHWARD HO!

ALTEN, July 27th.

THIS letter ought to be an Eclogue, so pastoral a life have we been leading lately among these pleasant Nordland valleys. Perhaps it is only the unusual sight of meadows, trees, and flowers, after the barren sea, and still more barren lands we have been accustomed to, that invests this neighborhood with such a smiling character. Be that as it may, the change has been too grateful not to have made us seriously reflect on our condition; and we have at last determined that not even the envious ocean shall for the future cut us off from the pleasures of a shepherd life. Henceforth, the boatswain is no longer to be the only swain on board! We have purchased an ancient goat—a nanny-goat—so we may be able to go a-milking upon occasion. Mr. Webster, late of her Majesty's Foot-guards, carpenter, etc., takes brevet-rank as dairy-maid; and our venerable passenger is at this moment being inducted into a sumptuous barrel[1] which I have had fitted up for her re-

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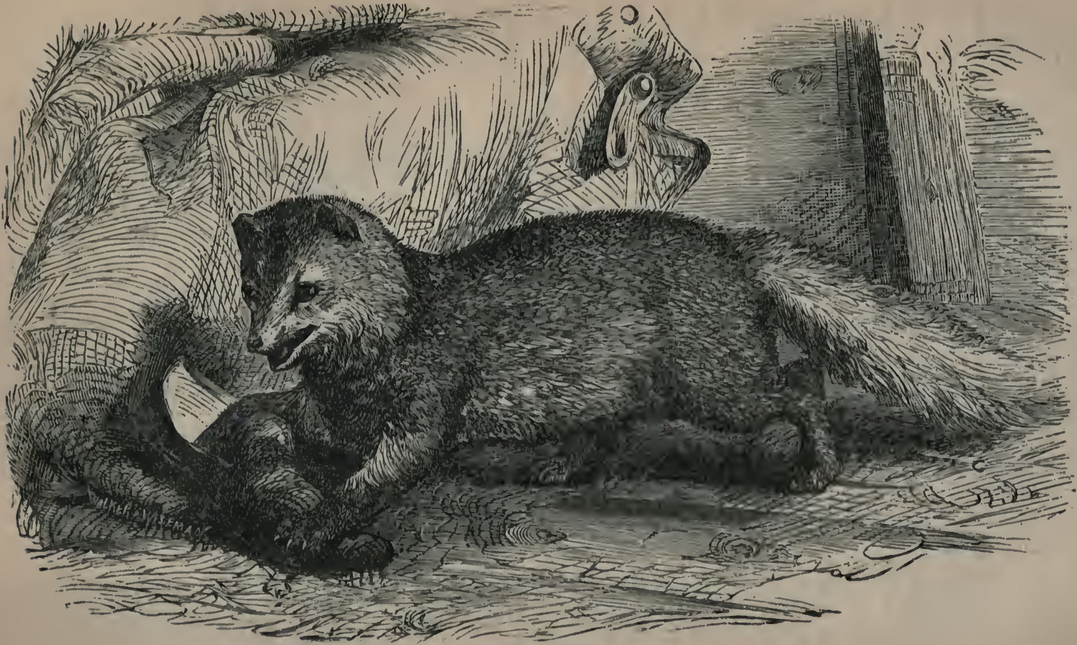
[1] The cask in question was bought in order to be rigged up eventually into a crow's-nest, as soon as we should again find ourselves among the ice.

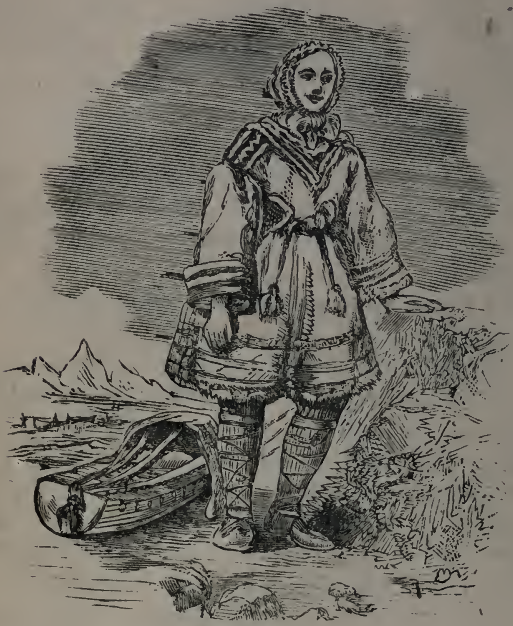


THE ICELANDIC FOX.

ception abaft the binnacle. A spacious meadow of sweet-scented hay has been laid down in a neighboring corner for her further accommodation; and the Doctor is tuning up his flageolet, in order to complete the bucolic character of the scene. The only personage amongst us at all disconcerted by these arrangements is the little white fox which has come with us from Iceland. Whether he considers the admission on board of so domestic an animal to be a reflection on his own wild Viking habits, I cannot say; but there is no impertinence—even to the nibbling of her beard when she is asleep—of which he is not guilty towards the poor old thing, who passes the greater part of her mornings in gravely butting at her irreverent tormentor.

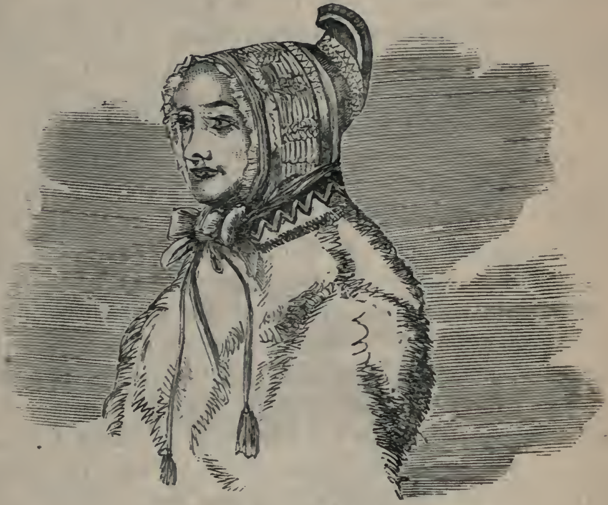
But I must relate our last week's proceeding in a more orderly manner.

As soon as the anchor was let go in Hammerfest harbor, we went ashore; and having first ascertained that the existence of a post does not necessarily imply letters, we turned away, a little disappointed, to examine the metropolis of Finmark. A nearer inspection did not improve the impression its first appearance had made upon us; and the odor of rancid cod-liver oil, which seemed indiscriminately to proceed from every building in the town, including the church, has irretrievably confirmed us in our prejudices. Nevertheless, henceforth the place will have one redeeming association connected with it, which I am bound to mention. It was in the streets of Hammerfest that I first set eyes on a Laplander. Turning round the corner of one of the ill-built houses, we suddenly ran over a diminutive little personage in a white woollen tunic, bordered with red and yellow stripes, green trousers, fastened round the ankles, and reindeer boots, curving up at the toes like Turkish slippers. On her head—for notwithstanding the trousers, she turned out to be a lady—was perched a gay particolored cap, fitting close round the face, and running up at the back into an overarching peak of red cloth. Within this peak was crammed—as I afterwards learnt—a piece of hollow wood, weighing about a quarter of a pound, into which is fitted the wearer's back hair; so that perhaps, after all, there *does* exist a more inconvenient *coiffure* that a Paris bonnet.



A LAPP LADY.

Hardly had we taken off our hats, and bowed a thousand apologies for our unintentional rudeness to the fair inhabitant of the green trousers, before a couple of Lapp gentlemen hove in sight. They were dressed pretty much like their companion, except that an ordinary red nightcap replaced the queer helmet worn by the lady; and the knife and sporran fastened to their belts, instead of being suspended in front as hers were, hung down against their hips. Their tunics, too, may have been a trifle shorter. None of the three were beautiful. High cheek-bones, short noses, oblique Mongol eyes, no eyelashes, and enormous mouths, composed a cast of features which their burnt-sienna complexion, and hair like ill-got-in hay did not much enhance. The expression of their countenances was not unintelligent; and there was a merry, half-timid, half-cunning twinkle in their eyes, which reminded me a little of faces I had met with in the more neglected districts of Ireland. Some ethnologists, indeed, are inclined to reckon the Laplanders as a branch of the Celtic family. Others, again, maintain them to be Ugrians; while a few pretend to discover a relationship between the Lapp language and the dialects of the Australian savages, and simi-



A LAPP LADY'S BONNET.

lar outsiders of the human family; alleging that as successive stocks bubbled up from the central birthplace of mankind in Asia, the earlier and inferior races were gradually driven outwards in concentric circles, like the rings produced by the throwing of a stone into a pond; and that consequently, those who dwell in the uttermost ends of the earth are, *ipso facto*, first cousins.

This relationship with the Polynesian Niggers, the native genealogists would probably scout with indignation, being perfectly persuaded of the extreme gentility of their descent. Their only knowledge of the patriarch Noah is as a personage who derives his principal claim to notoriety from having been the first Lapp. Their acquaintance with any sacred history—nay, with Christianity at all—is very limited. It was not until after the thirteenth century that an attempt was made to convert them; and although Charles the Fourth and Gustavus ordered portions of Scripture to be translated in Lappish, to this very day a great proportion of the race are pagans; and even the most illuminated amongst them remain slaves to the grossest superstition. When a couple is to be married, if a priest happens to be in the way, they will send for him perhaps out of complaisance; but otherwise, the young lady's papa merely strikes a flint and steel together, and the ceremony is not less irrevocably completed. When they die, a hatchet and a flint and steel are invariably buried with the defunct, in case he should find himself chilly on his long journey—an unnecessary precaution, many of the orthodox would consider, on the part of such lax religionists. When they go boar-hunting—the most important business in their lives—it is a sorcerer, with no other defence than his incantations, who marches at the head of the procession. In the internal arrangements of their tents, it is not a room to themselves, but a door to themselves, that they assign to their womankind; for woe betide the hunter if a woman has crossed the threshold over which he sallies to the chase; and for three days after the slaughter of his prey he must live apart from the female portion of his family in order to appease the evil deity whose familiar he is supposed to have destroyed. It would be endless to recount the innumerable occasions upon which the ancient rites of Jumala are still interpolated among the Christian observances they profess to have adopted.

Their manner of life I had scarcely any opportunities of observing. Our Consul kindly undertook to take us to one of their encampments; but they flit so often from place to place, it is very difficult to light upon them. Here and there, as we cruised about among the fiords, blue wreaths of smoke rising from some little green nook among the rocks would betray their temporary place of abode; but I never got a near view of a regular settlement.

In the summer-time they live in canvas tents: during winter, when the snow is on the ground, the forest Lapps build huts in the branches of trees, and so roost like birds. The principal tent is of an hexagonal form, with a fire in the centre, whose smoke rises through a hole in the roof. The gentlemen and ladies occupy different sides of the same apartment; but a long pole laid along the ground midway between them symbolizes an ideal partition, which I dare say is in the end as effectual a defence as lath and plaster prove in more civilized countries. At all events, the ladies have a doorway quite to themselves, which, doubtless, they consider a far greater privilege than the seclusion of a separate boudoir. Hunting and fishing are the principal employments of the Lapp tribes; and to slay a bear is the most honorable exploit a Lapp hero can achieve. The flesh of the slaughtered beast becomes the property—not of the man who killed him, but of him who discovered his trail, and the skin is hung up on a pole, for the wives of all who took part in the expedition to shoot at with their eyes bandaged. Fortunate is she whose arrow pierces the trophy,—not only does it become her prize, but, in the eyes of the whole settlement, her husband is looked upon thenceforth as the most fortunate of men. As long as the chase is going on, the women are not allowed to stir abroad; but as soon as the party have safely brought home their booty, the whole female population issue from their tents, and having deliberately chewed some bark of a species of alder, they spit the red juice into their husband's faces, typifying thereby the bear's blood which has been shed in the honorable encounter.

Although the forests, the rivers, and the sea supply them in a great measure with their food, it is upon the reindeer that the Laplander is dependent for every other comfort in life. The reindeer is his estate, his horse, his cow, his companion, and friend. He has twenty-two different names for him. His coat, trousers, and shoes are made of reindeer's skin, stitched with thread manufactured from the nerves and sinews of the reindeer. Reindeer milk is the most important item in his diet. Out of reindeer horns are made almost all the utensils used in his domestic economy; and it is the reindeer that carries his baggage, and drags his sledge. But the beauty of this animal is by no means on a par with his various moral and physical endowments. His antlers, indeed, are magnificent, branching back to the length of three or four feet; but his body is poor and his limbs thick and ungainly; neither is his pace quite so rapid as is generally supposed. The Laplanders count distances by the number of horizons they have traversed; and if a reindeer changes the horizon three times during the twenty-four hours, it is thought a good day's work. Moreover, so just an appreciation has the creature of what is due to his own great merit, that if his owner seeks to tax him beyond his strength, he not only becomes restive, but sometimes actually turns upon the inconsiderate Jehu who has over-driven him. When, therefore, a Lapp is in a great hurry, instead of taking to his sledge, he puts on a pair of skates exactly twice as long as his own body, and so flies on the wings of the wind.

Every Laplander, however poor, has his dozen or two dozen deer; and the flocks of a Lapp Crœsus amount sometimes to two thousand head. As soon as a young lady is born—after having been duly rolled in the snow—she is dowered by her father with a certain number of deer, which are immediately branded with her initials, and thenceforth kept apart as her especial property. In proportion as they increase and multiply does her chance improve of making a good match. Lapp courtships are conducted pretty much in the same fashion as in other parts of the world. The aspirant, as soon as he discovers that he has lost his heart, goes off in search of a friend and a bottle of brandy. The friend enters the tent, and opens simultaneously—the brandy—and his business; while the lover remains outside, engaged in hewing wood, or some other menial employment. If, after the brandy and the proposal have been duly discussed, the eloquence of his friend prevails, he is himself called into the conclave, and the young people are allowed to rub noses. The bride then accepts from her suitor a present of a reindeer's tongue, and the espousals are considered concluded. The marriage does not take place for two or three years afterwards; and during the interval the intended is obliged to labor in the service of his father-in-law, as diligently as Jacob served Laban for the sake of his long-loved Rachel.

I cannot better conclude this summary of what I have been able to learn about the honest Lapps, than by sending you the tourist's stock specimen of a Lapp love-ditty. The author is supposed to be hastening in his sledge towards the home of his adored one:—

"Hasten, Kulnasatz! my little reindeer! long is the way, and boundless are the marshes. Swift are we, and light of foot, and soon we shall have come to whither we are speeding. There shall I behold my fair one pacing. Kulnasatz, my reindeer, look forth! look around! Dost thou not see her somewhere—*bathing?*"

As soon as we had thoroughly looked over the Lapp lady and her companions, a process to which they submitted with the greatest complacency, we proceeded to inspect the other lions of the town; the church, the lazar-house,—principally occupied by Lapps,—the stock fish establishment, and the hotel. But a very few hours were sufficient to exhaust the pleasures of Hammerfest; so having bought an extra suit of jerseys for my people, and laid in a supply of other necessaries, likely to be useful in our cruise to Spitzbergen, we exchanged dinners with the Consul, a transaction by which, I fear, he got the worst of the bargain, and then got under way for this place,—Alten.

The very day we left Hammerfest our hopes of being able to get to Spitzbergen at all—received a tremendous shock. We had just sat down to dinner, and I was helping the Consul to fish, when in comes Wilson, his face, as usual, upside down, and hisses something into the Doctor's ear. Ever since the famous dialogue which had taken place between them on the subject of sea-sickness, Wilson had got to look upon Fitz as in some sort his legitimate prey; and whenever the burden of his own misgivings became greater than he could bear, it was to the Doctor that he unbosomed himself. On this occasion, I guessed, by the look of gloomy triumph in his eyes, that some great calamity had occurred, and it turned out that the following was the agreeable announcement he had been in such haste to make: "Do you know, Sir?"—This was always the preface to tidings unusually doleful. "No—what?" said the Doctor, breathless. "Oh nothing, Sir; only two sloops have just arrived, Sir, from Spitzbergen, Sir—where they couldn't get, Sir;—such a precious lot of ice—two hundred miles from the land—and, oh, Sir—they've come back with all their bows stove in!" Now, immediately on arriving at Hammerfest, my first care had been to inquire how the ice was lying this year to the northward, and I had certainly been told that the season was a very bad one, and that the most of the sloops that go every summer to kill sea-horses (*i. e.*, walrus) at Spitzbergen, being unable to reach the land, had returned empty-handed; but as three weeks of better weather had intervened since their discomfiture, I had quite reassured myself with the hope that in the mean time the advance of the season might have opened for us a passage to the island.

This news of Wilson's quite threw me on my back again. The only consolation was, that probably it was not true; so immediately after dinner we boarded the honest Sea-horseman who was reported to have brought the dismal intelligence. He turned out to be a very cheery intelligent fellow of about five-and-thirty, six feet high, with a dashing "devil-may-care" manner that completely imposed upon me. Charts were got out, and the whole state of the case laid before me in the clearest manner. Nothing could be more unpromising. The sloop had quitted the ice but eight-and-forty hours before making the Norway coast; she had not been able even to reach Bear Island. Two hundred miles of ice lay off the southern and western coast of Spitzbergen—(the eastern side is always blocked up with ice)—and then bent round in a continuous semicircle towards Jan Mayen. That they had not failed for want of exertion—the bows of his ships sufficiently testified. As to *our* getting there it was out of the question. So spake the Sea-horseman. On returning on board the "*Foam*" I gave myself up to the most gloomy reflections. This, then, was to be the result of all my preparations and long-meditated schemes. What likeli hood was there of success, after so unfavorable a verdict? *Ipse dixit*, *equus marinus*. It is true the horse-marines have hitherto been considered a mythic corps, but my friend was too substantial looking for me to doubt his existence; and unless I was to ride off on the proverbial credulity of the other branch of that amphibious profession, I had no reason to question his veracity. Nevertheless, I felt it would not become a gentleman to turn back at the first blush of discouragement. If it were possible to reach Spitzbergen, I was determined to do so. I reflected that every day that passed was telling in our favor. It was not yet the end of July; even in these latitudes winter does not commence much before September, and in the mean time the tail of the Gulf Stream would still be wearing a channel in the ice towards the pole; so, however unpromising might be the prospect, I determined, at all events, that we should go and see for ourselves how matters really stood.

But I must explain to you why I so counted upon the assistance of the Gulf Stream to help us through.

The entire configuration of the Arctic ice is determined by the action of that mysterious current on its edges. Several theories have been advanced to account for its influence in so remote a region. I give you one which appears to me reasonable. It is supposed, that in obedience to that great law of Nature which seeks to establish equilibrium in the temperature of fluids,—a vast body of gelid water is continually mounting from the Antarctic, to displace and regenerate the over-heated oceans of the torrid zone. Bounding up against the west side of South America, the ascending stream skirts the coasts of Chili and Peru, and is then deflected in a westerly direction across the Pacific Ocean, where it takes the name of the Equatorial Current. Having completely encircled Australia, it enters the Indian Sea, sweeps up round the Cape of

Good Hope, and, crossing the Atlantic, twists into the Gulf of Mexico. Here its flagging energies are suddenly accelerated in consequence of the narrow limits within which it finds itself compressed. So marvellous does the velocity of the current now become, so complete its isolation from the deep sea bed it traverses, that by the time it issues again into the Atlantic, its hitherto diffused and loitering waters are suddenly concentrated into what Lieutenant Maury has happily called—"a river in the ocean," swifter and of greater volume than either the Mississippi or the Amazon. Surging forth between the interstices of the Bahamas, that stretch like a weir across its mouth, it cleaves asunder the Atlantic. So distinct is its individuality, that one side of a vessel will be scoured by its warm indigo-colored water, while the other is floating in the pale, stagnant, weed-encumbered brine of the Mar de Sargasso of the Spaniards. It is not only by color, by its temperature, by its motion, that this "*ροὴ 'Ωχεανοῖο*" is distinguished; its very surface is arched upwards some way above the ordinary sea-level toward the centre, by the lateral pressure of the elastic liquid banks between which it flows. Impregnated with the warmth of tropic climes, the Gulf Stream—as it has now come to be called,—then pours its genial floods across the North Atlantic, laving the western coasts of Britain, Ireland, and Norway, and investing each shore it strikes upon, with a climate far milder than that enjoyed by other lands situated in the same latitudes. Arrived abreast of the North Cape, the impetus of the current is in a great measure exhausted.

From causes similar (though of less efficacy, in consequence of the smaller area occupied by water) to those which originally gave birth to the ascending energy of the Antarctic waters, a gelid current is also generated in the Arctic Ocean, which, descending in a south-westerly direction, encounters the already faltering Gulf Stream in the space between Spitzbergen and Nova Zembla. A contest for the mastery ensues, which is eventually terminated by a compromise. The warmer stream, no longer quite able to hold its own, splits into two branches, the one squeezing itself round the North Cape, as far as that Varangar Fiord which Russia is supposed so much to covet, while the other is pushed up in a more northerly direction along the west coast of Spitzbergen. But although it has power to split up the Gulf Stream for a certain distance, the Arctic current is ultimately unable to cut across it, and the result is an accumulation of ice to the south of Spitzbergen in the angle formed by the bifurcation, as Mr. Grote would call it, of the warmer current.

It is quite possible, therefore, that the north-west ex-extremity of Spitzbergen may be comparatively clear, while the whole of its southern coasts are enveloped in belts of ice of enormous extent. It was on this contingency that we built our hopes, and determined to prosecute our voyage, in spite of the discouraging report of the Norse skipper.

About eight o'clock in the evening we got under way from Hammerfest; unfortunately the wind almost immediately after fell dead calm, and during the whole night we lay "like a painted ship upon a painted ocean." At six o'clock a little breeze sprung up, and when we came on deck at breakfast time, the schooner was skimming at the rate of five knots an hour over the level lanes of water, which lie between the silver-grey ridges of gneiss and mica slate that hem in the Nordland shore. The distance from Hammerfest to Alten is about forty miles, along a zigzag chain of fiords. It was six o'clock in the evening, and we had already sailed two-and-thirty miles, when it again fell almost calm. Impatient at the unexpected delay, and tempted by the beauty of the evening,—which was indeed most lovely, the moon hanging on one side right opposite to the sun on the other, as in the picture of Joshua's miracle,—Sigurdr, in an evil hour, proposed that we should take a row in the dingy, until the midnight breeze should spring up, and bring the schooner along with it. Away we went and so occupied did we become with admiring the rocky precipices beneath which we were gliding, that it was not until the white sails of the motionless schooner had dwindled to a speck, that we became aware of the distance we had come.

Our attention had been further diverted by the spectacle of a tribe of fishes, whose habit it appeared to be—instead of swimming like Christian fishes in a horizontal position beneath the water—to walk upon their hind-legs along its surface. Perceiving a little boat floating on the loch not far from the spot where we had observed this phenomenon, we pulled towards it, and ascertained that the Lapp officer in charge was actually intent on stalking the peripatetic *school*—to use a technical expression—whose evolutions had so much astonished us. The great object of the sportsman is to judge by their last appearance what part of the water the fish are likely to select for the scene of their next promenade. Directly he has determined this in his own mind, he rows noiselessly to the spot, and, as soon as they show themselves, hooks them with a landing-net into his boat.

By this time it had become a doubtful point whether it would not be as little trouble to row on to Alten as to return to the schooner, so we determined to go on. Unfortunately we turned down a wrong fiord, and after a long pull, about two o'clock in the morning had the satisfaction of finding ourselves in a *cul-de-sac*. To add to our discomfort, clouds of mosquitoes with the bodies of behemoths and the stings of dragons, had collected from all quarters of the heavens to make a prey of us. In vain we struggled—strove to knock them down with the oars,—plunged our heads under the water,—smacked our faces with frantic violence; on they came in myriads, until I thought our bleaching bones would alone remain to indicate our fate. At last Sigurdr espied a log hut on the shore, where we might at least find some one to put us into the right road again; but on looking in at the open door, we only saw a Lapland gentleman fast asleep. Awaking at our approach, he started to his feet, and though nothing could be more gracefully conciliatory than the bow with which I opened the conversation, I regret to say that after staring wildly round for a few minutes, the aboriginal bolted straight away in the most unpolite manner and left us to our fate. There was nothing for it but patiently to turn back, and try some other opening. This time we were more successful, and about three o'clock, A. M., had the satisfaction of landing at one of the wharves attached to the copper mines of Kaafiord. We came upon a lovely scene. It was as light and warm as a summer's noon in England; upon a broad plateau, carved by nature out of the side of the grey limestone, stood a bright shining house in the middle of a plot of rich English-looking garden. On one side lay the narrow fiord, on every other rose an amphitheatre of fir-clad mountains. The door of the house was open, so were many of the windows—even those on the ground-floor, and from the road where we stood we could see the books on the library shelves. A swing and some gymnastic appliances on the lawn told us that there were children. Altogether, I thought I had never seen such a charming picture of silent comfort and security. Perhaps the barren prospects we had been accustomed to made the little oasis before us look more cheerful than we might otherwise have thought it.

The question now arose, what was to be done? My principal reason for coming to Alten was to buy some salt provisions and Lapland dresses; but dolls and junk were scarcely a sufficient pretext for knocking up a quiet family at three o'clock in the morning. It is true, I happened to have a letter for Mr. T——, written by a mutual friend, who had expressly told me that—arrive when I might at Alten,—the more unceremoniously I walked in and took possession of the first unoccupied bed I stumbled on, the better Mr. T—— would be pleased; but British punctilio would not allow me to act on the recommendation, though we were sorely tried. In the meantime the mosquitoes had become more intolerable than ever. At last, half mad with irritation, I set off straight up the side of the nearest mountain, in hopes of attaining a zone too high for them to inhabit; and, poising myself upon its topmost pinnacle, I drew my handkerchief over my head—I was already without coat and waistcoat—and remained the rest of the morning "mopping and mowing" at the world beneath my feet.

About six o'clock, like a phantom in a dream, the little schooner came stealing round the misty headland, and anchored at the foot of the rocks below. Returning immediately on board, we bathed, dressed, and found repose from all our troubles. Not long after, a message from Mr. T——, in answer to a card I had sent up to the house as soon as the household gave signs of being astir—invited us to breakfast; and about half past-nine we presented ourselves at his hospitable door. The reception I met with was exactly what the gentleman who had given me the letter of introduction had led me to expect; and so eager did Mr. T—— seem to make us comfortable, that I did not dare to tell him how we had been prowling about his house the greater part of the previous night, lest he should knock me down on the spot for not having knocked him up. The appearance of the inside of the house quite corresponded with what we had anticipated from the *soigné* air of everything about its exterior. Books, maps, pictures, a number of astronomical instruments, geological specimens, and a magnificent assortment of fishing-rods, betrayed the habits of the practical, well-educated, business-loving English gentleman who inhabited it; and as he showed me the various articles of interest in his study, most heartily did I congratulate myself on the lucky chance which had brought me into contact with so desirable an acquaintance.

All this time we had seen nothing of the lady of the house; and I was just beginning to speculate as to whether that crowning ornament could be wanting to this pleasant home when the door at the further end of the room suddenly opened, and there glided out into the sushine—"The White Lady of Avenel." A fairer apparition I have seldom seen,—stately, pale, and fragile as a lily—blond hair, that rippled round a forehead of ivory—a cheek of waxen purity on which the fitful color went and came—not with the flush of southern blood, or flower-bloom of English beauty,—but rather with a cool radiance, as of "northern streamers" on the snows of her native hills,—eyes of a dusky blue, and lips of that rare tint which lines the conch-shell. Such was the Châtelaine of Kaafiord,—as perfect a type of Norse beauty as ever my Saga lore had conjured up! Frithiof's Ingeborg herself seemed to stand before me. A few minutes afterwards, two little fair-haired maidens, like twin snow-drops, stole into the room; and the sweet home picture was complete.

The rest of the day has been a continued fête. In vain after having transacted my business, I pleaded the turning of the tide, and our anxiety to get away to sea; nothing would serve our kind entertainer but that we should stay to dinner; and his was one of those strong energetic wills it is difficult to resist.

In the afternoon, the Hammerfest steamer called in from the southward, and by her came two fair sisters of our hostess from their father's home in one of the Loffodens which overlook the famous Mäelstrom. The stories about the violence of the whirlpool Mr. T—— assures me are ridiculously exaggerated. On ordinary occasions the site of the supposed vortex is perfectly unruffled, and it is only when a strong weather tide is running that any unusual movements in the water can be observed; even then the disturbance does not amount to much more than a rather troublesome race. "Often and often, when she was a girl, had his wife and her sisters sailed over its fabulous crater in an open boat." But in this wild romantic country with its sparse population, rugged mountains, and gloomy fiords, very ordinary matters become invested with a character of awe and mystery quite foreign to the atmosphere of our own matter of fact world; and many of the Norwegians are as prone to superstition as the poor little Lapp pagans who dwell among them.

No later than a few years ago, in the very fiord we had passed on our way to Alten, when an unfortunate boat got cast away during the night on some rocks at a little distance from the shore, the inhabitants, startled by the cries, of distress which reached them in the morning twilight hurried down in a body to the sea-side,—not to afford assistance,—but to open a volley of musketry on the drowning mariners; being fully persuaded that the stranded boat, with its torn sails, was no other than the Kracken or Great Sea-Serpent flapping its dusky wings: and when, at last, one of the crew succeeded in swimming ashore in spite of waves and bullets,—the whole society turned and fled!

And now, again good-by. We are just going up to dine with Mr. T——; and after dinner, or at least as soon as the tide turns, we get under way—Northward Ho! (as Mr. Kingsley would say) in right good earnest this time!

LETTER XI.

WE SAIL FOR BEAR ISLAND, AND SPITZBERGEN—CHERIE ISLAND—BARENTZ—SIR HUGH WILLOUGHBY—PARRY'S ATTEMPT TO REACH THE NORTH POLE—AGAIN AMONGST THE ICE—ICEBLINK—FIRST SIGHT OF SPITZBERGEN—WILSON—DECAY OF OUR HOPES—CONSTANT STRUGGLE WITH THE ICE—WE REACH THE 80° N. LAT.—A FREER SEA—WE LAND IN SPITZBERGEN—ENGLISH BAY—LADY EDITH'S GLACIER—A MIDNIGHT PHOTOGRAPH—NO REIN-DEER TO BE SEEN—ET EGO IN ARCTIS—WINTER IN SPITZBERGEN — PTARMIGAN — THE BEAR SAGA — THE "FOAM" MONUMENT—SOUTHWARDS—SIGHT THE GREENLAND ICE—A GALE—WILSON ON THE MAELSTROM—BREAKERS AHEAD—ROOST—TAKING A SIGHT—THRONDHJEM.

Throndhjem, Aug. 22d, 1856.

WE have won our laurels, after all! We have landed in Spitzbergen—almost at its most northern extremity; and the little "*Foam*" has sailed to within 630 miles of the Pole; that is to say, within 100 miles as far north as any ship has ever succeeded in getting.

I think my last letter left us enjoying the pleasant hospitalities of Kaafiord.

The genial quiet of that last evening in Norway was certainly a strange preface to the scenes we have since witnessed. So warm was it, that when dinner was over, we all went out into the garden, and had tea in the open air; the ladies without either bonnets or shawls, merely plucking a little branch of willow to brush away the mosquitoes; and so the evening wore away in alternate intervals of chat and song. At midnight, seawards again began to swirl the tide, and we rose to go,—not without having first paid a visit to the room where the little daughters of the house lay folded in sleep. Then descending to the beach, laden with flowers and kind wishes waved to us by white handkerchiefs held in still whiter hands, we rowed on board; up went the flapping sails, and dipping her ensign in token of adieu—the schooner glided swiftly on between the walls of rock, until an intervening crag shut out from our sight the friendly group that had come forth to bid us "Good speed." In another twenty-four hours we had threaded our way back through the intricate fiords; and leaving Hammerfest three or four miles on the starboard hand, on the evening of the 28th of July, we passed out between the islands of Soroe and Bolsvoe into the open sea.

My intention was to go first to Bear Island, and ascertain for myself in what direction the ice was lying to the southward of Spitzbergen.

Bear—or Cherie Island, is a diamond-shaped island, about ten miles long, composed of secondary rocks—principally sandstone and limestone—lying about 280 miles due north of the North Cape. It was originally discovered by Barentz, the 9th of June, 1596, on the occasion of his last and fatal voyage. Already had he commanded two expeditions sent forth by the United Provinces to discover a north-east passage to that dream-land—Cathay; and each time, after penetrating to the eastward of Nova Zembla, he had been foiled by the impenetrable line of ice. On this occasion he adopted the bolder and more northerly courses which brought him to Bear Island. Thence, plunging into the mists of the frozen sea, he ultimately sighted the western mountains of Spitzbergen. Unable to proceed further in that direction, Barentz retraced his steps, and again passing in sight of Bear Island, proceeded in a south-east direction to Nova Zembla, where his ships got entangled in the ice, and he subsequently perished.

Towards the close of the sixteenth century, in spite of repeated failures, one endeavor after another was made to penetrate to India across these fatal waters.

The first English vessel that sailed on the disastrous quest was the "*Bona Esperanza*," in the last year of King Edward VI. Her commander was Sir Hugh Willoughby, and we have still extant a copy of the instructions drawn up by Sebastian Cabot—the Grand Pilot of England, for his guidance. Nothing can be more pious than the spirit in which this ancient document is conceived; expressly enjoining that morning and evening prayers should be offered on board every ship attached to the expedition, and that neither dicing, carding, tabling, nor other devilish devices—were to be permitted. Here and there were clauses of a more questionable morality,—recommending that natives of strange lands be "enticed on board, and made drunk with your beer and wine; for then you shall know the secrets of their hearts." The whole concluding with an exhortation to all on board to take especial heed to the devices of "certain creatures, with men's heads, and the tails of fishes, who swim with bows and arrows about the fiords and bays, and live on human flesh."

On the 11th of May the ill-starred expedition got under way from Deptford, and saluting the king, who was then lying sick at Greenwich, put to sea. By the 30th of July the little fleet—three vessels in all—had come up abreast of the Loffoden islands, but a gale coming on, the "*Esperanza*" was separated from the consorts. Ward-huus—a little harbor to the east of the North Cape—had been appointed as the place of rendezvous in case of such an event, but unfortunately, Sir Hugh overshot the mark, and wasted all the precious autumn time in blundering amid the ice to the eastward. At last, winter set in, and they were obliged to run for a port in Lapland. Here, removed from all human aid, they were frozen to death. A year afterwards, the ill-fated ships were discovered by some Russian sailors, and an unfinished journal proved that Sir Hugh and many of his companions were still alive in January, 1554.

The next voyage of discovery in a north-east direction was sent out by Sir Francis Cherie, alderman of London, in 1603. After proceeding as far east as Ward-huus and Kela, the "*Godspeed*" pushed north into the ocean, and on the 16th of August fell in with Bear Island. Unaware of its previous discovery by Barentz, Stephen Bennet —who commanded the expedition—christened the island Cherie Island, in honor of his patron, and to this day the two names are used almost indiscriminately.

In 1607, Henry Hudson was despatched by the Muscovy Company, with orders to sail, if possible right across the pole. Although perpetually baffled by the ice, Hudson at last succeeded in reaching the north-west extremity of Spitzbergen, but finding his further progress arrested by an impenetrable barrier of fixed ice, he was forced to return. A few years later, Jonas Poole—having been sent in the same direction, instead of prosecuting any discoveries, wisely set himself to killing the sea-horses that frequent the Arctic ice-fields, and in lieu of tidings of new lands—brought back a valuable cargo of walrus tusks. In 1615, Fortherby started with the intention of renewing the attempt to sail across the north pole, but after encountering many dangers he also was forced to return. It was during the course of his homeward voyage that he fell in with the island of Jan Mayen. Soon afterwards, the discovery by

Hudson and Davis, of the seas and straits to which they had given their names, diverted the attention of the public from all thoughts of a north-east passage, and the Spitzbergen waters were only frequented by ships engaged in the fisheries. The gradual disappearance of the whale, and the discovery of more profitable fishing stations on the west coast of Greenland, subsequently abolished the sole attraction for human being which this inhospitable region ever possessed, and of late years, I understand, the Spitzbergen seas have remained as lonely and unvisited as they were before the first adventurer invaded their solitude.

Twice only, since the time of Fotherby, has any attempt been made to reach the pole on a north-east course. In 1773, Captain Phipps, afterwards Lord Mulgrave, sailed in the "*Carcass*" towards Spitzbergen, but he never reached a higher latitude than 81°. It was in this expedition that Nelson made his first voyage, and had that famous encounter with the bear. The next and last endeavor was undertaken by Parry, in 1827. Unable to get his ship even as far north as Phipps had gone, he determined to leave her in a harbor in Spitzbergen, and push across the sea in boats and sledges. The uneven nature of the surface over which they had to travel, caused their progress northward to be very slow, and very laborious. The ice too, beneath their feet, was not itself immovable, and at last they perceived they were making the kind of progress a criminal makes upon the treadmill,—the floes over which they were journeying drifting to the southward faster than they walked north; so that at the end of a long day's march of ten miles, they found themselves four miles further from their destination than at its commencement. Disgusted with so Irish a manœuvre, Parry determined to return, though not until he had almost reached the 83rd parallel, a higher latitude than any to which man is known to have penetrated. Arctic authorities are still of opinion, that Parry's plan for reaching the north pole might prove successful, if the expedition were to set out earlier in the season, ere the intervening field of ice is cast adrift by the approach of summer.

Our own run to Bear Island was very rapid. On getting outside the island, a fair fresh wind sprung up, and we went spinning along for two nights and two days as merrily as possible, under a double-reefed mainsail and staysail, on a due north course. On the third day we began to see some land birds, and a few hours afterwards, the loom of the island itself; but it had already begun to get fearfully cold and our thermometer, which I consulted every two hours, plainly indicated that we were approaching ice. My only hope was that, at all events, the southern extremity of the island might be disengaged; for I was very anxious to land, in order to examine some coal-beds which are said to exist in the upper strata of the sandstone formation. This expectation was doomed to complete disappointment. Before we had got within six miles of the shore, it became evident that the report of the Hammerfest Sea-horseman was too true.

Between us and the land there extended an impenetrable barrier of packed ice, running due east and west, as far as the eye could reach.

What was now to be done? If a continuous field of ice lay 150 miles off the southern coast of Spitzbergen, what would be the chance of getting to the land by going further north? Now that we had received ocular proof of the veracity of the Hammerfest skipper in this first particular, was it likely that we should have the luck to find the remainder of his story untrue? According to the track he had jotted down for me on the chart, the ice in front stretched right away west in an unbroken line, to the wall of ice which we had seen running to the north, from the upper end of Jan Mayen. Only a week had elapsed since he had actually ascertained the impracticability of reaching a higher latitude,—what likelihood could there be of a channel having been opened up to the northward during so short an interval? Such was the series of insoluble problems by which I posed myself, as we stood vainly smacking our lips at the island, which lay so tantalizingly beyond our reach.

Still, unpromising as the aspect of things might appear, it would not do to throw a chance away; so I determined to put the schooner round on the other tack, and run westwards along the edge of the ice, until we found ourselves again in the Greenland sea. Bidding, therefore, a last adieu to Mount Misery, as its first discoverers very appropriately christened one of the higher hills in Bear Island, we suffered it to melt back into a fog,—out of which, indeed, no part of the land had ever more than partially emerged,—and with no very sanguine expectations as to the result, sailed west away towards Greenland. During the next four-and-twenty hours we ran along the edge of the ice, in nearly a due westerly direction, without observing the slightest indication of anything approaching to an opening towards the North. It was weary work, scanning that seemingly interminable barrier, and listening to the melancholy roar of waters on its icy shore.

At last, after having come about 140 miles since leaving Bear Island,—the long, white, wave-lashed line suddenly ran down into a low point, and then trended back with a decided inclination to the North. Here, at all events, was an improvement; instead of our continuing to steer W. by S., or at most W .by N., the schooner would often lay as high up as N.W., and even N.W. by N. Evidently the action of the Gulf Stream was beginning to tell, and our spirits rose in proportion. In a few more hours, however, this cheering prospect was interrupted by a fresh line of ice being reported, not only ahead, but as far as the eye

IN THE ICE.

could reach on the port bow; so again the schooner's head was put to the westward, and the old story recommenced. And now the flank of the second barrier was turned, and we were able to edge up a few hours to the northward; but only to be again confronted by another line, more interminable, apparently, than the last. But why should I weary you with the detail of our various manœuvres during the ensuing days? They were too tedious and disheartening at the time, for me to look back upon them with any pleasure. Suffice it to say, that by dint of sailing north whenever the ice would permit us, and sailing west when we could not sail north, we found ourselves on the 2d of August, in the latitude of the southern extremity of Spitzbergen, though divided from the land by about fifty miles of ice. All this while the weather had been very good, foggy and cold enough, but with a fine stiff breeze that rattled us along at a good rate whenever we did get a chance of making any Northing. But lately it had come on to blow very hard, the cold became quite piercing, and what was worse—in every direction round the whole circuit of the horizon, except along its southern segment,—a blaze of iceblink illuminated the sky. A more discouraging spectacle could not have met our eyes. The iceblink is a luminous appearance, reflected on the heavens from the fields of ice that still lie sunk beneath the horizon; it was, therefore on this occasion an unmistakable indication of the encumbered state of the sea in front of us.

I had turned in for a few hours of rest, and release from the monotonous sense of disappointment, and was already lost in a dream of deep bewildering bays of ice, and gulfs whose shifting shores offered to the eye every possible combination of uncomfortable scenery, without possible issue,—when "a voice in my dreaming ear" shouted "*Land!*" and I awoke to its reality. I need not tell you in what double quick time I tumbled up the companion, or with what greediness I feasted my eyes on that longed-for view,—the only sight—as I then thought—we were ever destined to enjoy of the mountains of Spitzbergen!

The whole heaven was overcast with a dark mantle of tempestuous clouds, that stretched down in umbrella-like points towards the horizon, leaving a clear space between their edge and the sea, illuminated by the sinister brilliancy of the iceblink. In an easterly direction, this belt of unclouded atmosphere was etherealized to an indescribable transparency, and up into it there gradually grew—above the dingy line of starboard ice—a forest of thin lilac peaks, so faint, so pale, that had it not been for the gem-like distinctness of their outline, one could have deemed them as unsubstantial as the spires of fairy-land. The beautiful vision proved only too transient; in one short half hour mist and cloud had blotted it all out, while a fresh barrier of ice compelled us to turn our backs on the very land we were striving to reach.

Although we were certainly upwards of sixty miles distant from the land when the Spitzbergen hills were first observed, the intervening space seemed infinitely less; but in these high latitudes the eye is constantly liable to be deceived in the estimate it forms of distances. Often, from some change suddenly taking place in the state of the atmosphere, the land you approach will appear even to *recede;* and on one occasion, an honest skipper—one of the most valiant and enterprising mariners of his day—actually turned back, because, after sailing for several hours with a fair wind towards the land, and finding himself no nearer to it than at first, he concluded that some loadstone rock beneath the sea must have attracted the keel of his ship, and kept her stationary.

The next five days were spent in a continual struggle with the ice. On referring to our log, I see nothing but a repetition of the same monotonous observations.

"July 31st.—Wind W. by S.—Courses sundry to clear ice."

"Ice very thick."

"These twenty-four hours picking our way through ice."

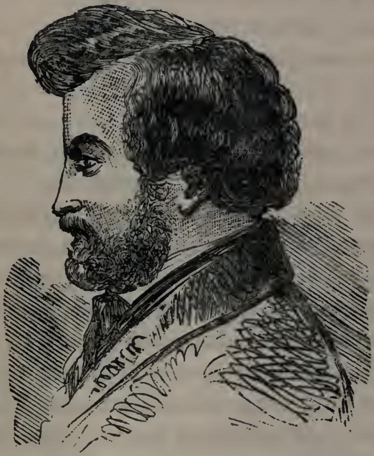
"August 1st.—Wind W.—courses variable—foggy—continually among ice these twenty-four hours."

And in Fitz's diary, the discouraging state of the weather is still more pithily expressed:—

"August 2d.—Head wind—sailing westward—large hummocks of ice ahead, and on port bow, *i. e.* to the westward—hope we may be able to push through. In evening, ice gets thicker; we still hold on—fog comes on—ice getting thicker—wind freshens—we can get no farther—ice impassable, no room to tack—struck the ice several times—obliged to sail S. and W.—things look very shady."

Sometimes we were on the point of despairing altogether, then a plausible opening would show itself as if leading towards the land, and we would be tempted to run down it until we found the field become so closely packed, that it was with great difficulty we could get the vessel round—and only then at the expense of collisions, which made the little craft shiver from stem to stern. Then a fog would come on—so thick, you could almost cut it like a cheese—and thus render the sailing among the loose ice very critical indeed; then it would fall dead calm, and leave us, hours together, muffled in mist, with no other employment than chess or hopscotch. It was during one of those intervals of quiet that I executed the annexed work of art, which is intended to represent Sigurdr, in the act of meditating a complicated gambit for the Doctor's benefit.

About this period Wilson culminated. Ever since leaving Bear Island he had been keeping a carnival of grief in the pantry, until the cook became almost half-witted by reason of his Jeremiads. Yet I must not give you the impression that the poor fellow was the least wanting in *pluck*—far from it. Surely it requires the highest order of courage to anticipate every species of disaster every moment of the day, and yet to meet the impending fate like a man—as he did. Was it his fault that fate was not equally ready to meet him? *His* share of the business was always done: he was ever prepared for the worst; but the most critical circumstances never disturbed the gravity of his carriage, and the fact of our being destined to go to the bottom before tea-time would not have caused him to lay out the dinner table a whit less symmetrically. Still, I own, the style of his service was slightly depressing. He laid out my clean shirt of a morning as if it had been a shroud; and cleaned my boots as though for a man *on his last legs*. The fact is, he was imaginative and atrabilious,—contemplating life through a medium of the color of his own complexion.



SIGURDR.

This was the cheerful kind of report he used invariably to bring me of a morning. Coming to the side of my cot with the air of a man announcing the stroke of doomsday, he used to say, or rather, *toll*—

"Seven o'clock, my Lord!"

"Very well; how's the wind?"

"Dead ahead, my Lord—*dead!*"

"How many points is she off her course?"

"Four points, my Lord—full four points!" (Four points being as much as she could be.)

"Is it pretty clear? eh! Wilson?"

"—Can't see your hand, my Lord!—can't see your hand!"

"Much ice in sight?"

"—Ice all round, my Lord—ice a-all ro-ound!"—and so exit, sighing deeply over my trousers.

Yet it was immediately after one of these unpromising announcements, that for the first time matters began to look a little brighter. The preceding four-and-twenty hours we had remained enveloped in a cold and dismal fog. But on coming on deck, I found the sky had already begun to clear; and although there was ice as far as the eye could see on either side of us, in front a narrow passage showed itself across a patch of loose ice into what seemed a freer sea beyond. The only consideration was—whether we could be certain of finding our way out again, should it turn out that the open water we saw was only a basin without any exit in any other direction. The chance was too tempting to throw away; so the little schooner gallantly pushed her way through the intervening neck of ice where the floes seemed to be least huddled up together, and in half an hour afterwards found herself running up along the edge of the starboard ice, almost in a due northerly direction. And here I must take occasion to say that, during the whole of this rather anxious time, my master—Mr. Wyse—conducted himself in a most admirable manner.

Vigilant, cool, and attentive, he handled the vessel most skilfully, and never seemed to lose his presence of mind in any emergency. It is true the silk tartan still coruscated on Sabbaths, but its brilliant hues were quite a relief to the colorless scenes which surrounded us, and the dangling chain now only served to remind me of what firm dependence I could place upon its wearer.

Soon after, the sun came out, the mist entirely disappeared and again on the starboard hand shone a vision of the land; this time not in the sharp peaks and spires we had first seen, but in a chain of pale blue egg-shaped islands, floating in the air a long way above the horizon. This peculiar appearance was the result of extreme refraction, for, later in the day, we had an opportunity of watching the oval cloudlike forms gradually harden into the same pink tapering spikes which originally caused the island to be called Spitzbergen: nay, so clear did it become, that even the shadows on the hills became quite distinct, and we could easily trace the outlines of the enormous glaciers —sometimes ten or fifteen miles broad—that fill up every valley along the shore. Towards evening the line of coast again vanished into the distance, and our rising hopes received an almost intolerable disappointment by the appearance of a long line of ice right ahead, running to the westward, apparently, as far as the eye could reach. To add to our disgust, the wind flew right round into the North, and increasing to a gale, brought down upon us—not one of the usual thick arctic mists to which we were accustomed but a dark, yellowish brown fog, that rolled along the surface of the water in twisted columns, and irregular masses of vapor, as dense as coal smoke. We had now almost reached the eightieth parallel of north latitude, and still an impenetrable sheet of ice, extending fifty or sixty miles westward from the shore, rendered all hopes of reaching the land out of the question. Our expectation of finding the north-west extremity of the island disengaged from ice by the action of the currents was—at all events for this season—evidently doomed to disappointment. We were already almost in the latitude of Amsterdam Island—which is actually its north-west point—and the coast seemed more encumbered than ever. No whaler had ever succeeded in getting more than about 120 miles further north than we ourselves had already come; and to entangle ourselves any further in the ice—unless it were with the certainty of reaching land—would be sheer folly. The only thing to be done was to turn back. Accordingly, to this course I determined at last to resign myself, if, after standing on for twelve hours longer, nothing should turn up to improve the present aspect of affairs. It was now eleven o'clock; P.M. Fitz and Sigurdr went to bed, while I remained on deck to see what the night might bring forth. It blew great guns, and the cold was perfectly intolerable; billow upon billow of black fog came sweeping down between sea and sky, as if it were going to swallow up the whole universe; while the midnight sun—now completely blotted out—now faintly struggling through the ragged breaches of the mist—threw down from time to time an unearthly red-brown glare on the waste of roaring waters.

For the whole of that night did we continue beating up along the edge of the ice, in the teeth of a whole gale of wind; at last about nine o'clock in the morning,—but two short hours before the moment at which it had been agreed we should bear up, and abandon the attempt,—we came up with a long low point of ice, that had stretched further to the Westward than any we had yet doubled; and there, beyond, lay an open sea!—open not only to the Northward and westward, but also to the Eastward! You can imagine my excitement. "Turn the hands up, Mr. Wyse!" "'Bout ship!" "Down with the helm!" "Helm a-lee!" Up comes the schooner's head to the wind, the sails flapping with the noise of thunder—blocks rattling against the deck, as if they wanted to knock their brains out—ropes dancing about in galvanized coils, like mad serpents—and everything to an inexperienced eye in inextricable confusion; till gradually she pays off on the other tack—the sails stiffen into deal-boards—the staysail sheet is let go—and heeling over on the opposite side, again she darts forward over the sea like an arrow from the bow. "Stand by to make sail!" "Out all reefs!" I could have carried sail to sink a man-of-war!—and away the little ship went, playing leapfrog over the heavy seas, and staggering under her canvas, as if giddy with the same joyful excitement which made my own heart thump so loudly.

In another hour the sun came out, the fog cleared away, and about noon—up again, above the horizon, grow the pale lilac peaks, warming into a rosier tint as we approach. Ice still stretches toward the land on the starboard side; but we don't care for it now—the schooner's head is pointing E. and by S. At one o'clock we sight Amsterdam Island, about thirty miles on the port bow; then came the "seven ice hills"—as seven enormous glaciers are called—that roll into the sea between lofty ridges of gneiss and mica slate, a little to the northward of Prince Charles's Foreland. Clearer and more defined grows the outline of the mountains, some coming forward while others recede; their rosy tints appear less even, fading here and there into pale yellows and greys; veins of shadow score the steep sides of the hills; the articulations of the rocks become visible; and now, at last, we glide under the limestone peaks of Mitre Cape, past the marble arches of King's Bay on the one side, and the pinnacle of the Vogel Hook on the other, into the quiet channel that separates the Foreland from the main.

It was at one o'clock in the morning of the 6th of August, 1856, that after having been eleven days at sea, we

NIGHT SUN OFF SPITZBERGEN

came to an anchor in the silent haven of English Bay, *Spitzbergen.*

And now, how shall I give you an idea of the wonderful panorama in the midst of which we found ourselves? I think, perhaps, its most striking feature was the stillness, and deadness, and impassibility of this new world: ice, and rock, and water surrounded us; not a sound of any kind interrupted the silence; the sea did not break upon the shore; no bird or any living thing was visible; the midnight sun, by this time muffled in a transparent mist, shed an awful, mysterious lustre on glacier and mountain; no atom of vegetation gave token of the earth's vitality: an universal numbness and dumbness seemed to pervade the solitude. I suppose in scarcely any other part of the world is this appearance of deadness so strikingly exhibited. On the stillest summer day in England, there is always perceptible an under-tone of life thrilling through the atmosphere; and though no breeze should stir a single leaf, yet—in default of motion—there is always a sense of growth; but here not so much as a blade of grass was to be seen on the sides of the bald excoriated hills. Primeval rocks and eternal ice constitute the landscape.

The anchorage where we had brought up is the best to be found, with the exception perhaps of Magdalena Bay, along the whole west coast of Spitzbergen; indeed it is almost the only one where you are not liable to have the ice set in upon you at a moment's notice. Ice Sound, Bell Sound, Horn Sound—the other harbors along the west coast—are all liable to be beset by drift-ice during the course of a single night, even though no vestige of it may have been in sight four-and-twenty hours before; and many a good ship has been inextricably imprisoned in the very harbor to which she had fled for refuge. This bay is completely landlocked, being protected on its open side by Prince Charles's Foreland, a long island lying parallel with the mainland. Down towards either horn run two ranges of schistose rocks, about 1,500 feet high, their sides almost precipitous, and the topmost ridge as sharp as a knife, and jagged as a saw; the intervening space is entirely filled up by an enormous glacier, which,—descending with one continuous incline from the head of a valley on the right, and sweeping like a torrent round the roots of an isolated clump of hills in the centre—rolls at last into the sea. The length of the glacial river from the spot where it apparently first originated, could not have been less than thirty, or thirty-five miles, or its greatest breadth less than nine or ten; but so completely did it fill up the higher end of the valley, that it was as much as you could do to distinguish the further mountains peeping up above its surface. The height of the precipice where it fell into the sea, I should judge to have been about 120 feet.

On the left a still more extraordinary sight presented itself. A kind of baby glacier actually hung suspended half way on the hill side, like a tear in the act of rolling down the furrowed cheek of the mountain.

I have tried to convey to you a notion of the falling impetus impressed on the surface of the Jan Mayen ice rivers; but in this case so unaccountable did it seem that the overhanging mass of ice should not continue to thunder down upon its course, that one's natural impulse was to shrink from crossing the path along which a breath—a sound—might precipitate the suspended avalanche into the valley. Though, perhaps, pretty exact in outline and general effect, the sketch I have made of this wonderful scene, will never convey to you a correct notion of the enormous scale of the distances, and size of its various features.

These glaciers are the principal characteristic of the scenery in Spitzbergen; the bottom of every valley in every part of the island, is occupied and generally completely filled by them, enabling one in some measure to realize the look of England during her glacial period, when Snowdon was still being slowly lifted towards the clouds, and every valley in Wales was brimful of ice. But the glaciers in English Bay are by no means the largest in the island. We ourselves got a view—though a very distant one—of ice rivers which must have been more extensive; and Dr. Scoresby mentions several which actually measured forty or fifty miles in length, and nine or ten in breadth; while the precipice formed by their fall into the sea, was sometimes upward of 400 or 500 feet high. Nothing is more dangerous than to approach these cliffs of ice. Every now and then huge masses detach themselves from the face of the crystal steep, and topple over into the water; and woe be to the unfortunate ship which might happen to be passing below. Scoresby himself actually witnessed a mass of ice, the size of a cathedral, thunder down into the sea from a height of 400 feet; frequently during our stay at Spitzbergen we ourselves observed specimens of these ice avalanches; and scarcely an hour passed without the solemn silence of the bay being disturbed by the thunderous boom resulting from similar catastrophes occurring in adjacent valleys.

As soon as we had thoroughly taken in the strange features of the scene around us, we all turned in for a night's rest. I was dog tired, as much with anxiety as want of sleep; for in continuing to push on to the northward in spite of the ice, I naturally could not help feeling that if any accident occurred, the responsibility would rest with me; and although I do not believe that we were at any time in any real danger, yet from our inexperience in the peculiarities of arctic navigation, I think the coolest judgment would have been liable to occasional misgivings as to what might arise from possible contingencies. Now, however, all was right; the result had justified our anticipations; we had reached the so longed-for goal; and as I stowed myself snugly away in the hollow of my cot, I could not help heartily congratulating myself that—for that night at all events—there was no danger of the ship knocking a hole in her bottom against some hummock which the lookout had been too sleepy to observe; and that Wilson could not come in the next morning and announce "ice all round, a-all ro-ound!" In a quarter of an hour afterwards, all was still on board the "*Foam;*" and the lonely little ship lay floating on the glassy bosom of the sea, apparently as inanimate as the landscape.

My feelings on awakening next morning were very pleasant; something like what one used to feel the first morning after one's return from school, on seeing pink curtains glistening round one's head, instead of the dirty-white boards of a turned-up bedstead. When Wilson came in with my hot water, I could not help triumphantly remarking to him,— "Well, Wilson, you see we've got to Spitzbergen, after all." But Wilson was not a man to be driven from his convictions by facts; he only smiled grimly, with a look which meant—"Would we were safe back again!" Poor Wilson! he would have gone only half way with Bacon in his famous Apothegm; he would willingly "commit the Beginnings of all actions to Argus with his hundred eyes, and the Ends"—to Centipede, with his hundred legs. "First to watch, and then to speed"—*away!* would have been his pithy emendation.

Immediately after breakfast we pulled to the shore, carrying in the gig with us the photographic apparatus, tents, guns, ammunition, and the goat. Poor old thing! she had suffered dreadfully from sea-sickness, and I thought a run ashore might do her good. On the left-hand side of the bay, between the foot of the mountain and the sea, there ran a low flat belt of black moss, about half a mile broad; and as this appeared the only point in the neighborhood likely to offer any attraction to reindeer, it was on this side that I determined to land. My chief reason for having run into English Bay rather than Magdalena Bay was because we had been told at Hammerfest that it was the more likely place of the two for deer; and as we were sadly in want of fresh meat this advantage quite decided us in our choice. As soon, therefore, as we had superintended the erection of the tent, and set Wilson hard at work cleaning the glasses for the photographs, we slung our rifles on our backs, and set off in search of deer. But in vain did I peer through my telescope across the dingy flat in front; not a vestige of a horn was to be seen, although in several places we came upon impressions of their track. At last our confidence in the reports of their great plenty became considerably diminished. Still the walk was very refreshing after our confinement on board; and although the thermometer was below freezing, the cold only made the exercise more pleasant. A little to the northward I observed, lying on the sea-shore, innumerable logs of driftwood. This wood is floated all the way from America by the Gulf Stream, and as I walked from one huge bole to another, I could not help wondering in what primeval forest each had grown, what chance had originally cast them on the waters, and piloted them to this desert shore. Mingled with this fringe of unhewn timber that lined the beach lay waifs and strays of a more sinister kind; pieces of broken spars, an oar, a boat's flagstaff, and a few shattered fragments of some long-lost vessel's planking. Here and there, too, we would come upon skulls of walrus, ribs and shoulder-blades of bears, brought possibly by the ice in winter. Turning again from the sea, we resumed our search for deer; but two or three hours' more very stiff walking produced no better luck. Suddenly a cry from Fitz, who had wandered a little to the right, brought us helter-skelter to the spot where he was standing. But it was not a stag he had called us to come and look upon. Half imbedded in the black moss at his feet, there lay a grey deal coffin falling almost to pieces with age; the lid was gone—blown off probably by the wind—and within were stretched the bleaching bones of a human skeleton. A rude cross at the head of the grave still stood partially upright, and a half obliterated Dutch inscription preserved a record of the dead man's name and age.

. . . . . VANDER SCHELLING . . . .
COMMAN . . . . . JACOB MOOR . . .
OB 2 JUNE 1758 ÆT 44.

It was evidently some poor whaler of the last century to whom his companions had given the only burial possible in this frost-hardened earth, which even the summer sun has no force to penetrate beyond a couple of inches, and which will not afford to man the shallowest grave. A bleak resting-place for that hundred years' slumber, I thought, as I gazed on the dead mariner's remains!—

"I was snowed over with snow,
And beaten with rains,
And drenched with the dews;
Dead have I long been,"—

—murmured the Vala to Odin in Nifelheim,—and whispers of a similar import seemed to rise up from the lidless coffin before us. It was no brother mortal that lay at our feet, softly folded in the embraces of "Mother Earth," but a poor scarecrow, gibbeted for ages on this bare rock, like a dead Prometheus; the vulture, frost, gnawing for ever on his bleaching relics, and yet eternally preserving them!

On another part of the coast we found two other corpses yet more scantily sepulchred, without so much as a cross to mark their resting-place. Even in the palmy days of the whale-fisheries, it was the practice of the Dutch and English sailors to leave the wooden coffins in which they had placed their comrades' remains, exposed upon the shore; and I have been told by an eye-witness, that in Magdalena Bay there are to be seen, even to this day, the bodies of men who died upwards of 250 years ago, in such complete preservation that, when you pour hot water on the icy coating which encases them, you can actually see the unchanged features of the dead, through the transparent incrustation.

As soon as Fitz had gathered a few of the little flowering mosses that grew inside the coffin, we proceeded on our way, leaving poor Jacob Moor—like his great namesake—alone in his glory.

Turning to the right, we scrambled up the spur of one of the mountains on the eastern side of the plain, and thence dived down among the lateral valleys that run up between them. Although by this means we opened up quite a new system of hills, and basins, and gullies, the general scenery did not change its characteristics. All vegetation—if the black moss deserves such a name—ceases when you ascend twenty feet above the level of the sea, and the sides of the mountains become nothing but steep slopes of schist, split and crumbled into an even surface by the frost. Every step we took unfolded a fresh succession of these jagged spikes and break-neck acclivities, in an unending variety of quaint configuration. Mountain climbing has never been a hobby of mine, so I was not tempted to play the part of Excelsior on any of these hill sides; but for those who love such exercise a fairer or a more dangerous opportunity of distinguishing themselves could not be imagined. The super-cargo or owner of the very first Dutch ship that ever came to Spitzbergen, broke his neck in attempting to climb a hill in Prince Charles's Foreland. Barentz very nearly lost several of his men under similar circumstances; and when Scoresby succeeded in making the ascent of another hill near Horn Sound, it was owing to his having taken the precaution of marking each upward step in chalk, that he was ever able to get down again. The prospect from the summit, the approach to which was by a ridge so narrow that he sat astride upon its edge, seems amply to have repaid the exertion; and I do not think I can give you a better idea of the general effect of Spitzbergen scenery, than by quoting his striking description of the panorama he beheld:—

"The prospect was most extensive and grand. A fine sheltered bay was seen to the east of us, an arm of the same on the north-east, and the sea, whose glassy surface was unruffled by a breeze, formed an immense expanse on the west; the icebergs rearing their proud crests almost to the tops of mountains between which they were lodged, and defying the power of the solar beams, were scattered in various directions about the sea-coast and in the adjoining bays. Beds of snow and ice filling extensive hollows, and giving an enamelled coat to adjoining valleys, one of which commencing at the foot of the mountain where we stood extended in a continued line towards the north, as far as the eye could reach—mountain rising above mountain, until by distance they dwindled into insignificancy—the whole contrasted by a cloudless canopy of deepest azure, and enlightened by the rays of a blazing sun, and the effect aided by a feeling of danger, seated as we were on the pinnacle of a rock almost surrounded by tremendous precipices,—all united to constitute a picture singularly sublime.

"Our descent we found really a very hazardous, and in some instances a painful undertaking. Every movement was a work of deliberation. Having by much care, and with some anxiety, made good our descent to the top of the secondary hills, we took our way down one of the steepest banks, and slid forward with great facility in a sitting posture. Towards the foot of the hill, an expanse of snow stretched across the line of descent. This being loose and soft, we entered upon it without fear; but on reaching the middle of it, we came to a surface of solid ice, perhaps a hundred yards across, over which we launched with astonishing velocity, but happily escaped without injury. The men whom we left below, viewed this latter movement with astonishment and fear."

So universally does this strange land bristle with peaks and needles of stone, that the views we ourselves obtained —though perhaps from a lower elevation, and certainly without the risk—scarcely yielded either in extent or picturesque grandeur to the scene described by Dr. Scoresby.

Having pretty well overrun the country to the northward, without coming on any more satisfactory signs of deer than their hoof-prints in the moss, we returned on board. The next day—but I need not weary you with a journal of our daily proceedings; for, however interesting each moment of our stay in Spitzbergen was to ourselves— as much perhaps from a vague expectation of what we might see, as from anything we actually did see—a minute account of every walk we took, and every bone we picked up, or every human skeleton we came upon, would probably only make you wonder why on earth we should have wished to come so far to see so little. Suffice it to say that we explored the neighborhood in the three directions left open to us by the mountains, that we climbed the two most accessible of the adjacent hills, wandered along the margin of the glaciers, rowed across to the opposite side of the bay, descended a certain distance along the sea-coast, and in fact exhausted all the lions of the vicinity.

During the whole period of our stay in Spitzbergen, we had enjoyed unclouded sunshine. The nights were even brighter than the days, and afforded Fitz an opportunity of taking some photographic views by the light of a *midnight* sun. The cold was never very intense, though the thermometer remained below freezing; but about four o'clock every evening, the salt-water bay in which the schooner lay was veneered over with a pellicle of ice one eighth of an inch in thickness, and so elastic, that even when the sea beneath was considerably agitated, its surface remained unbroken, the smooth, round waves taking the appearance of billows of oil. If such is the effect produced by the slightest modification of the sun's power, in the month of August,—you can imagine what must be the result of his total disappearance beneath the horizon. The winter is, in fact, unendurable. Even in the height of summer, the moisture inherent in the atmosphere is often frozen into innumerable particles, so minute as to assume the appearance of an impalpable mist. Occasionally persons have wintered on the island, but unless the greatest precautions have been taken for their preservation, the consequences have been almost invariably fatal. About the same period as when the party of Dutch sailors were left at Jan Mayen, a similar experiment was tried in Spitzbergen. At the former place it was scurvy, rather than cold, which destroyed the poor wretches left there to fight it out with winter; at Spitzbergen, as well as could be gathered from their journal, it appeared that they had perished from the intolerable severity of the climate,—and the contorted attitudes in which their bodies were found lying, too plainly indicated the amount of agony they had suffered. No description can give an adequate idea of the intense rigor of the six months' winter in this part of the world. Stones crack with the noise of thunder; in a crowded hut the breath of its occupants will fall in flakes of snow; wine and spirits turn to ice; the snow burns like caustic; if iron touches the flesh, it brings the skin away with it; the soles of your stockings may be burnt off your feet, before you feel the slightest warmth from the fire; linen taken out of boiling water, instantly stiffens to the consistency of a wooden board; and heated stones will not prevent the sheets of the bed from freezing. If these are the effects of the climate within an air tight, fire-warmed, crowded hut—what must they be among the dark, storm-lashed mountain-peaks outside?

It was now time to think of going south again; we had spent many more days on the voyage to Spitzbergen than I had expected, and I was continually haunted by the dread of your becoming anxious at not hearing from us. It was a great disappointment to be obliged to return without having got any deer; but your peace of mind was of more consequence to me than a ship-load of horns; and accordingly we decided on not remaining more than another day in our present berth, leaving it still an open question whether we should not run up to Magdalena Bay, if the weather proved very inviting, the last thing before quitting for ever the Spitzbergen shores.

We had killed nothing as yet, except a few eider ducks, and one or two ice-birds—the most graceful winged creatures I have ever seen, with immensely long pinions, and plumage of spotless white. Although enormous seals from time to time used to lift their wise, grave faces above the water, with the dignity of sea-gods, none of us had any great inclination to slay such rational human-looking creatures; and—with the exception of these and a white fish, a species of whale—no other living thing had been visible. On the very morning, however, of the day settled for our departure, Fitz came down from a solitary expedition up a hill with the news of his having seen some ptarmigan. Having taken a rifle with him instead of a gun, he had not been able to shoot more than one, which he had brought back in triumph as proof of the authenticity of his report; but the extreme juvenility of his victim hardly permitted us to identify the species; the hole made by the bullet being about the same size as the bird. Nevertheless, the slightest prospect of obtaining a supply of fresh meat was enough to reconcile us to any amount of exertion; therefore, on the strength of the pinch of feathers which Fitz kept gravely assuring us was the game he had bagged, we seized our guns—I took a rifle in case of a possible bear—and set our faces toward the hill. After a good hour's pull we reached the shoulder which Fitz had indicated as the scene of his exploit, but a patch of snow was the only thing visible. Suddenly I saw Sigurdr, who was remarkably sharp-sighted, run rapidly in the direction of the snow, and bringing his gun up to his shoulder, point it —as well as I could distinguish—at his own toes. When the smoke of the shot had cleared away, I fully expected to see the Icelander prostrate; but he was already reloading with the greatest expedition. Determined to prevent the repetition of so dreadful an attempt at self-destruction, I rushed to the spot. Guess then my relief when the bloody body of a ptarmigan—driven by so point blank a discharge a couple of feet into the snow—was triumphantly dragged forth by instalments from the sepulchre which it had received contemporaneously with its death wound, and thus happily accounted for Sigurdr's extraordinary proceeding. At the same moment I perceived two or thee dozen other birds, brothers and sisters of the defunct, calmly strutting about under our very noses. By this time Sigurdr had reloaded, Fitz had also come up, and a regular massacre began. Retiring to a distance—for it was the case of Mahomet and the mountain reversed—the two sportsmen opened fire upon the innocent community, and in a few seconds sixteen corpses strewed the ground.

Scarcely had they finished off the last survivor of this Niobean family, when we were startled by the distant report of a volley of musketry, fired in the direction of the schooner. I could not conceive what had happened. Had a mutiny taken place? Was Mr. Wyse re-enacting, with a less docile ship's company, the pistol scene on board the

Glasgow steamer? Again resounded the rattle of the firing. At all events, there was no time to be lost in getting back; so, tying up the birds in three bundles, we flung ourselves down into the gully by which we had ascended, and leaping on from stone to stone, to the infinite danger of our limbs and necks, rolled rather than ran down the hill. On rounding the lower wall of the curve which hitherto had hid what was passing from our eyes, the first I observed was Wilson breasting up the hill, evidently in a state of the greatest agitation. As soon as he thought himself within earshot, he stopped dead short, and, making a speaking-trumpet with his hands, shrieked, rather than shouted, "If you please, my Lord!"—(as I have already said, Wilson never forgot *les convenances*)—"If you please, my Lord, there's a b-e-a-a-a-a-r!" prolonging the last word into a polysyllable of fearful import. Concluding by the enthusiasm he was exhibiting, that the animal in question was at his heels,—hidden from us probably by the inequality of the ground,—I cocked my rifle, and prepared to roll him over the moment he should appear in sight. But what was my disappointment, when on looking towards the schooner, my eye caught sight of our three boats fastened in a row, and towing behind them a white floating object, which my glass only too surely resolved the next minute into the dead bear!

On descending to the shore, I learned the whole story.

As Mr. Wyse was pacing the deck, his attention was suddenly attracted by a white speck in the water, swimming across from Prince Charles' Foreland,—the long island which lies over against English Bay. When first observed, the creature, whatever it might be, was about a mile and a half off,—the width of the channel between the island and the main being about five miles. Some said it was a bird, others a whale, and the cook suggested a mermaid. When the fact was ascertained that it was a *bonâ* *fide* bear, a gun was fired as a signal for us to return; but it was evident that unless at once intercepted, Bruin would get ashore. Mr. Wyse, therefore, very properly determined to make sure of him. This was a matter of no difficulty; the poor beast showed very little fight. His first impulse was to swim away from the boat; and even after he had been wounded, he only turned round once or twice upon his pursuers. The honor of having given him his death wound, rests between the steward and Mr. Wyse; both contend for it. The evidence is conflicting, as at least half-a-dozen mortal wounds were found in the animal's body; each may be considered to have had a share in his death. Mr. Grant rests his claim principally upon the fact of his having put two bullets in my new rifle—which must have greatly improved the bore of that instrument. On the strength of this precaution, he now wears as an ornament about his person one of the bullets extracted from the gizzard of our prize.

All this time, Wilson was at the tent, busily occupied in taking photographs. As soon as the bear was observed, a signal was made to him from the ship, to warn him of the visitor he might shortly expect on shore. Naturally concluding that the bear would in all probability make for the tent as soon as he reached land, it became a subject of consideration with him what course he should pursue. Weapons he had none, unless the chemicals he was using might be so regarded. Should he try the influence of chloroform on his enemy; or launch the whole photographic apparatus at his grizzly head, and take to his heels? Thought is rapid, but the bear's progress seemed equally expeditious: it was necessary to arrive at some speedy conclusion. To fly—was to desert his post and leave the camp in possession of the spoiler; life and honor were equally dear to him. Suddenly a bright idea struck him.

At the time the goat had been disembarked to take her pleasure on *terra firma*, our crow's-nest barrel had been landed with her. At this moment it was standing unoccupied by the side of the tent. By creeping into it, and turning its mouth downward on the ground, Wilson perceived that he should convert it into a tower of strength for himself against the enemy, while its legitimate occupant, becoming at once a victim to the bear's voracity, would probably prevent the monster from investigating too curiously its contents. It was quite a pity that the interposition of the boats prevented his putting this ingenious plan into execution. He had been regularly *done* out of a situation, in which the most poignant agony of mind and dreary anticipations would have been absolutely required of him. He pictured the scene to himself; he lying fermenting in the barrel, like a curious vintage; the bear snuffing querulously round it, perhaps cracking it like a cocoa-nut, or extracting him like a periwinkle! Of these chances he had been deprived by the interference of the crew. Friends are often injudiciously meddling.

Although I felt a little vexation that one of us should not have had the honor of slaying the bear in single combat, which would certainly have been for the benefit of his skin, the unexpected luck of having got one at all, made us quite forget our personal disappointment. As for my people, they were beside themselves with delight. To have killed a polar bear was a great thing, but to eat him would be a greater. If artistically dealt with, his carcase would probably cut up into a supply of fresh meat for many days. One of the hands happened to be a butcher. Whenever I wanted anything a little out of the way to be done on board, I was sure to find that it happened to be the *spécialité* of some one of the ship's company. In the course of a few hours, the late bear was converted into a row of the most tempting morsels of beef, hung about the rigging. Instead of in flags, the ship was dressed in joints. In the mean time it so happened that the fox, having stolen a piece of offal, was in a few minutes afterwards seized with convulsions. I had already given orders that the bear's liver should be thrown overboard, as being, if not poisonous, at all events very unwholesome. The seizure of the fox, coupled with this injunction, brought about a complete revolution in the men's minds, with regard to the delicacies they had been so daintily preparing for themselves. Silently, one by one, the pieces were untied and thrown into the sea; I do not think a mouthful of bear was eaten on board the "*Foam*." I never heard whether it was in consequence of any prognostics of Wilson's that this act of self-denial was put into practice. I observed, however, that for some days after the slaughter and dismemberment of the bear, my ship's company presented an unaccountably sleek appearance. As for the steward, his head and whiskers seemed carved out of black marble; a varnished boot would not have looked half so bright; I could have seen to shave myself in his black hair. I conclude, therefore, that the ingenious cook must, at all events, have succeeded in manufacturing a supply of genuine bear's grease, of which they had largely availed themselves.

The bagging of the bear had so gloriously crowned our visit to Spitzbergen, that our disappointment about the deer was no longer thought of; it was therefore with light hearts, and most complete satisfaction, that we prepared for departure.

Maid Marian had already carved on a flat stone an inscription, in Roman letters, recording the visit of the "*Foam*" to English Bay; and a cairn having been erected to receive it, the tablet was solemnly lifted to its resting-place. Underneath I placed a tin box, containing a memorandum similar to that left at Jan Mayen, as well as a printed dinner invitation from Lady ——, which I happened to have on board. Having planted a boat's flag beside the rude monument, and brought on board with us a load of drift-wood to serve hereafter as Christmas yule-logs, we bade an eternal adieu to the silent hills around us; and weighing anchor, stood out to sea. For some hours a lack of wind still left us hanging about the shore, in the midst of a grave society of seals; but soon after, a gentle breeze sprang up in the south, and about three o'clock on Friday, the 11th of August, we again found ourselves spanking along before a six-knot breeze, over the pale green sea.

In considering the course on which I should take the vessel home, it appeared to me that in all probability we should have been much less pestered by the ice on our way to Spitzbergen, if, instead of hugging the easterly ice, we had kept more away to the westward; I determined therefore—as soon as we got clear of the land—to stand right over to the Greenland shore, on a due west course, and not to attempt to make any southing, until we should have struck the Greenland ice. The length of our tether in that direction being ascertained, we could then judge of the width of the channel down which we were to beat, for it was still blowing pretty fresh from the southward.

Up to the evening of the day on which we quitted English Bay, the weather had been most beautiful; calm, sunshiny, dry, and pleasant. Within a few hours of our getting under weigh, a great change had taken place, and by midnight it had become as foggy and disagreeable as ever. The sea was pretty clear. During the few days we had been on shore, the northerly current had brushed away the great angular field of ice which had lain off the shore, in a north-west direction; so that instead of being obliged to run up very nearly to the 80th parallel, in order to round it, we were enabled to sail to the westward at once. During the course of the night, we came upon one or two wandering patches of drift ice, but so loosely packed that we had no difficulty in pushing through them. About four o'clock in the morning, a long line of close ice was reported right a-head, stretching south as far as the eye could reach. We had come about eighty miles since leaving Spitzbergen. The usual boundary of the Greenland ice in summer runs, according to Scoresby, along the second parallel of west longitude. This we had already crossed; so that it was to be presumed the barricade we saw before us was a frontier of the fixed ice. In accordance, therefore, with my predetermined plan, we now began working to the southward, and the result fully justified my expectations.

The sea became comparatively clear, as far as could be seen from the deck of the vessel; although small vagrant patches of ice that we came up with occasionally—as well as the temperature of the air and the sea—continued to indicate the proximity of larger bodies on either side of us.

It was a curious sensation with which we had gradually learnt to contemplate this inseparable companion; it had become a part of our daily existence, an element, a thing without which the general aspect of the universe would be irregular and incomplete. It was the first thing we thought of in the morning, the last thing we spoke of at night. It glittered and grinned maliciously at us in the sunshine; it winked mysteriously through the stifling fog; it stretched itself like a prostrate giant, with huge, portentous shoulders and shadowy limbs, right across our course; or danced gleefully in broken groups in the little schooner's wake. There was no getting rid of it, or forgetting it; and if at night we sometimes returned in dreams to the green summer world—to the fervent harvest fields of England, and heard "the murmurs of innumerous bees," or the song of larks on thymy uplands—thump! bump! splash! gra-a-te! —came the sudden reminder of our friend on the starboard bow; and then sometimes a scurry on deck, and a general "scrimmage" of the whole society, in endeavors to prevent more serious collisions. Moreover, I could not say, with your old French friend, that "Familiarity breeds despise." The more we saw of it, the less we liked it; its cold presence sent a chilly sense of discouragement to the heart, and I had daily to struggle with an ardent desire to throw a boot at Wilson's head, every time his sepulchral voice announced the "Ice *all around!*"

It was not until the 14th of August, five days after quitting Spitzbergen, that we lost sight of it altogether. From that moment the temperature of the sea steadily rose, and we felt that we were sailing back again into the pleasant summer.

A sad event which occurred soon after, in some measure marred our enjoyment of the change. Ever since she had left Hammerfest, it had become too evident that a seagoing life did not agree with the goat. Even the run on shore at Spitzbergen had not sufficed to repair her shattered constitution, and the bad weather we had had ever since completed its ruin. It was certain that the butcher was the only doctor who could now cure her. In spite, therefore, of the distress it occasioned Maid Marian, I was compelled to issue orders for her execution. Sigurdr was the only person who regarded the *tragical* event with indifference, nay, almost with delight. Ever since we had commenced sailing in a southerly direction, we had been obliged to beat; but during the last four-and-twenty hours the wind kept dodging us every time we tacked, as a nervous pedestrian sets to you sometimes on a narrow *trottoir*. This spell of ill-luck the Icelander heathenishly thought would only be removed by a sacrifice to Rhin, the goddess of the sea, in which light he trusted she would look upon the goat's body when it came to be thrown overboard.

Whether the change which followed upon the consignment of her remains to the deep really resulted from such an influence, I am not prepared to say. The weather immediately thereafter certainly *did* change. First the wind dropped altogether; but though the calm lasted several hours, the sea strangely enough appeared to become all the rougher, tossing and tumbling restlessly *up and down*—(not over and over as in a gale)—like a sick man on a fever bed; the impulse to the waves seeming to proceed from all four quarters of the world at once. Then like jurymen with a verdict of death upon their lips, the heavy, ominous clouds slowly passed into the north-west.

A dead stillness followed—a breathless pause—until, at some mysterious signal, the solemn voice of the storm hurtled over the deep. Luckily we were quite ready for it; the gale came from the right quarter, and the fiercer it blew the better. For the next three days and three nights it was a scurry over the sea such as I never had before; nine or ten knots an hour was the very least we ever went, and 240 miles was the average distance we made every four-and twenty hours.

Anything grander and more exciting than the sight of the sea under these circumstances you cannot imagine. The vessel herself remains very steady; when you are below you scarcely know you are not in port. But on raising your head above the companion the first sight which meets your eye is an upright wall of black water, towering, you hardly know how many feet, into the air over the stern. Like a lion walking on its hind legs, it comes straight at you, roaring and shaking its white mane with fury—it overtakes the vessel—the upright shiny face curves inwards—the white mane seems to hang above your very head; but ere it topples over, the nimble little ship has already slipped from underneath. You hear the disappointed jaws of the sea-monster snap angrily together,—the schooner disdainfully kicks up her heel—and raging and bubbling up on either side the quarter, the unpausing wave sweeps on, and you see its round back far ahead, gradually swelling upwards, as it gathers strength and volume for a new effort.

We had now got considerably to the southward of North Cape. We had already seen several ships, and you would hardly imagine with what childish delight my people hailed these symptoms of having again reached more "Christian latitudes," as they called them

I had always intended, ever since my conversation with Mr. T. about the Mäelstrom, to have called in at Loffoden Islands on our way south, and ascertain for myself the real truth about this famous vortex. To have blotted such a bugbear out of the map of Europe, if its existence really was a myth, would at all events have rendered our cruise not altogether fruitless. But, since leaving Spitzbergen, we had never once seen the sun, and to attempt to make so dangerous a coast in a gale of wind and a thick mist, with no more certain knowledge of the ship's position than our dead reckoning afforded, was out of the question; so about one o'clock in the morning, the weather giving no signs of improvement, the course I had shaped in the direction of the island was altered, and we stood away again to the southward. This manœuvre was not unobserved by Wilson, but he mistook its meaning. Having, I suppose, overheard us talking at dinner about the Mäelstrom, he now concluded the supreme hour had arrived. He did not exactly comprehend the terms we used, but had gathered that the spot was one fraught with danger. Concluding from the change made in the vessel's course that we were proceeding towards the dreadful locality, he gave himself up to despair, and lay tossing in his hammock in sleepless anxiety. At last the load of his forebodings was greater than he could bear; he gets up, steals into the Doctor's cabin, wakes him up, and standing over him—as the messenger of ill tidings once stood over Priam—whispers, "*Sir!*" "What is it?" says Fitz, thinking, perhaps, some one was ill. "Do you know where we are going?" "Why, to Throndhjem," answered Fitz. "We *were* going to Throndhjem," rejoins Wilson, "but we ain't now—the vessel's course was altered two hours ago. Oh, Sir! we are going to Whirlpool—to *Whirl-rl-pooo-l!* Sir!" in a quaver of consternation,—and so glides back to bed like a phantom, leaving the Doctor utterly unable to divine the occasion of his visit.

The whole of the next day the gale continued. We had now sailed back into night; it became therefore a question how far it would be advisable to carry on during the ensuing hours of darkness, considering how uncertain we were as to our real position. As I think I have already described to you, the west coast of Norway is very dangerous; a continuous sheet of sunken rocks lies out along its entire edge for eight or ten miles to sea. There are no lighthouses to warn the mariner off; and if we were wrong in our reckoning, as we might very well be, it was possible we might stumble on the land sooner than we expected. I knew the proper course would be to lie to quietly until we could take an observation; but time was so valuable, and I was so fearful you would be getting anxious. The night was pretty clear. High mountains, such as we were expecting to make, would be seen, even at night, several miles off. According to our log we were still 150 miles off the land, and, however inaccurate our calculation might be, the error could not be of such magnitude as that amounted to. To throw away so fair a wind seemed such a pity, especially as it might be days before the sun appeared; we had already been at sea about a fortnight without a sight of him, and his appearance at all during the summer is not an act *de rigueur* in this part of the world; we might spend yet another fortnight in lying to, and then after all have to poke our way blindfold to the coast; at all events it would be soon enough to lie to the next night. Such were the considerations, which—after an anxious consultation with Mr.

Wyse in the cabin, and much fingering of the charts,—determined me to carry on during the night.

Nevertheless, I confess I was very uneasy. Though I went to bed and fell asleep—for at sea nothing prevents that process—my slumbers were constantly agitated by the most vivid dreams that I ever remember to have had. Dreams of an arrival in England, and your coming down to meet us, and all the pleasure I had in recounting our adventures to you; then suddenly your face seemed to fade away beneath a veil of angry grey surge that broke over low, sharp-pointed rocks; and the next moment there resounded over the ship that cry which has been the preface to so many a disaster—the ring of which, none who have ever heard it are likely to forget—"Breakers ahead!"

In a moment I was on deck, dressed—for it is always best to dress,—and there, sure enough, right ahead, about a mile and a half off, through the mist, which had come on very thick, I could distinguish the upward shooting fluff of seas shattering against rocks. No land was to be seen, but the line of breakers every instant became more evident; at the pace we were going, in seven or eight minutes we should be upon them. Now, thought I to myself, we shall see whether a stout heart beats beneath the silk tartan! The result covered that brilliant garment with glory and salt water. To tack was impossible, we could only wear,—and to wear in such a sea was no very pleasant operation. But the little ship seemed to know what she was about, as well as any of us: up went the helm, round came the schooner into the trough of the sea,—high over her quarter toppled an enormous sea, built up of I know not how many tons of water, and hung over the deck;—by some unaccountable wriggle, an instant ere it thundered down, she had twisted her stern on one side, and the waves passed underneath. In another minute her head was to the sea, the mainsail was eased over, and all danger was past.

What was now to be done? That the land we had seen was the coast of Norway I could not believe. Wrong as our dead reckoning evidently was, it could not be so wrong as that. Yet only one other supposition was possible, viz., that we had not come so far south as we imagined, and that we had stumbled upon Roost—a little rocky island that lies about twenty miles to the southward of the Loffoden Islands. Whether this conjecture was correct or not, did not much matter; to go straight away to sea, and lie to until we could get an observation, was the only thing to be done. Away then we went, struggling against a tremendous sea for a good nine hours, until we judged ourselves to be seventy or eighty miles from where we had sighted the breakers,—when we lay to, not in the best of tempers. The next morning, not only was it blowing as hard as ever, but all chance of getting a sight that day seemed also out of the question. I could have eaten my head with impatience. However, as it is best never to throw a chance away, about half-past eleven o'clock, though the sky resembled an even sheet of lead, I got my sextant ready, and told Mr. Wyse to do the same.

Now, out of tenderness for your feminine ignorance I must state, that in order to take an observation, it is necessary to get a sight of the sún at a particular moment of the day: this moment is noon. When, therefore, twelve o'clock came, and one could not so much as guess in what quarter of the heavens he might be lying *perdu*, you may suppose I almost despaired. Ten minutes passed. It was evident we were doomed to remain, kicking our heels for another four-and-twenty hours where we were. No!—yes!—no! By Phœbus! there he is! A faint spongy spot of brightness gleamed through the grey roof overhead. The indistinct outline grew a little clearer; one-half of him, though still behind a cloud, hardened into a sharp edge. Up went the sextant. "52.43!" (or whatever it was) I shouted to Mr.

"THE GIRLS AT HOME HAVE GOT HOLD OF THE TOW-ROPE."

Wyse. "52.41, my Lord!" cried he, in return; there was only the discrepancy of a mile between us. We had got the altitude; the sun might go to bed for good and all now, we did not care,—we knew our position to an inch. There had been an error of something like forty miles in our dead reckoning, in consequence—as I afterwards found—of a current that sets to the northward, along the west coast of Norway, with a velocity varying from one to three miles an hour. The island upon which we had so nearly run *was* Roost. We were still nearly 200 miles from our port. "Turn the hands up! Make sail!" and away we went again in the same course as before, at the rate of ten knots an hour.

"The girls at home have got hold of the tow-rope, I think, my Lord," said Mr. Wyse, as we bounded along over the thundering seas.

By three o'clock next day we were up with Vigten; and now a very nasty piece of navigation began. In order to make the northern entrance of the Thrŏndhjem Fiord, you have first to find your way into what is called the Froh Havet,—a kind of oblong basin about sixteen miles long, formed by a ledge of low rocks running parallel with the mainland, at a distance of ten miles to seaward. Though the space between this outer boundary and the coast is so wide, in consequence of the network of sunken rocks which stuffs it up, the passage by which a vessel can enter is very narrow, and the only landmark to enable you to find the channel is the head one of the string of outer islets. As this rock is about the size of a dining-table, perfectly flat, and rising only a few feet above the level of the sea, to attempt to make it is like looking for a needle in a bottle of hay. It was already beginning to grow very late and dark by the time we had come up with the spot where it ought to have been, but not a vestige of such a thing had turned up. Should we not sight it in a quarter of an hour, we must go to sea again, and lie to for the night, —a very unpleasant alternative for any one so impatient as I was to reach a port. Just as I was going to give the order, Fitz—who was certainly the Lynceus of the ship's company—espied its black back just peeping up above the tumbling water on our starboard bow. We had hit it off to a yard!

In another half-hour we were stealing down in quiet water towards the entrance of the fiord. All this time not a rag of a pilot had appeared; and it was without any such functionary that the schooner swept up next morning between the wooded, grain-laden slopes of the beautiful loch, to Throndhjem—the capital of the ancient sea-kings of Norway.

LETTER XII.

THRONDHJEM—HARALD HAARFAGER—KING HACON'S LAST BATTLE—OLAF TRYGGVESSON—THE "LONG SERPENT"—ST. OLAVE—THORMOD THE SCALD—THE JARL OF LADE—THE CATHEDRAL—HARALD HARDRADA—THE BATTLE OF STANFORD BRIDGE—A NORSE BALL—ODIN—AND HIS PALADINS.

Off MUNKHOLM, Aug. 27, 1856.

THRONDHJEM (pronounced Tronyem) looked very pretty and picturesque, with its red-roofed wooden houses sparkling in the sunshine, its many windows filled with flowers, its bright fiord covered with vessels gayly dressed in flags, in honor of the Crown Prince's first visit to the ancient capital of the Norwegian realm. Tall, pretentious warehouses crowded down to the water's edge, like bullies at a public show elbowing to the foremost rank; orderly streets stretched in quiet rows at right angles with each other, and pretty villas with green cinctures sloped away towards the hills. In the midst rose the king's palace, the largest wooden edifice in Europe; while the old grey Cathedral—stately and grand in spite of the slow destruction of the elements, the mutilations of man's hands, or his yet more degrading rough-cast and stucco reparations—still towered above the perishable wooden buildings at his feet, with the solemn pride which befits the shrine of a royal saint.

I cannot tell you with what eagerness I drank in all the features of this lovely scene; at least, such features as

Time can hardly alter—the glancing river, from whence the city's ancient name of Nidaros, or "mouth of the Nid," is derived,—the rocky island of Munkholm, the bluff of of Ladé,—the land-locked fiord and its pleasant hills, beyond whose grey stony ridges I knew must lie the fatal battle-field of Sticklestad. Every spot to me was full of interest,—but an interest noways connected with the neat green villas, the rectangular streets, and the obtrusive warehouses. These signs of a modern humdrum prosperity seemed to melt away before my eyes as I gazed from the schooner's deck, and the accessories of an elder time came to furnish the landscape ;—the clumsy merchantmen lazily swaying with the tide, darkened into armed galleys with their rows of glittering shields,—the snug, bourgeois-looking town shrank into the quaint proportions of the huddled ancient Nidaros,—and the old marauding days, with their shadowy line of grand old pirate kings, rose up with welcome vividness before my mind.

What picture shall I try to conjure from the past, to live in your fancy, as it does in mine ?

Let the setting be these very hills,—flooded by this same cold, steely sunshine. In the midst stands a stalwart form, in quaint but regal attire. Hot blood deepens the color of his sun-bronzed cheek ; an iron purpose gleams in his earnest eyes, like the flash of a drawn sword ; a circlet of gold binds the massive brow, and from beneath it stream to blow his waist thick masses of hair, of that dusky red which glows like the heart of a furnace in the sunlight, but deepens earthbrown in the shadow. By his side stands a fair woman ; her demure and heavy-lidded eyes are seldom lifted from the earth, which yet they seem to scorn ; but the king's eyes rest on her, and many looks are turned towards him. A multitude is present, moved by one great event, swayed by a thousand passions ;—some with garrulous throats full of base adulation and an unworthy joy ;

—some pale, self-scorning, with averted looks, and hands that twitch instinctively at their idle daggers, then drop hopeless, harmless at their sides.

The king is Harald Haarfager, "of the fair hair;" the woman is proud and beautiful Gyda, whose former scorn for him, in the days when he was nothing but the petty chief of a few barren mountains, provoked that strange wild vow of his, "That he would never clip or comb his locks till he could woo her as sole king of Norway."

Among the crowd are those who have bartered, for ease, and wealth, and empty titles born of the king's breath—their ancient Udal rights, their Bonder privileges; others have sunk their proud hearts to bear the yoke of the stronger hand, yet gaze with yearning looks on the misty horizon that opens between the hills. A dark speck mars that shadowy line. Thought follows across the space. It is a ship. Its sides are long, and black, and low; but high in front rises the prow, fashioned into the semblance of a gigantic golden dragon, against whose gleaming breast the divided waters angrily flash and gurgle. Along the top sides of the deck are hung a row of shining shields, in alternate breadths of red and white, like the variegated scales of a sea-monster, whilst its glided tail curls aft over the head of the steersman. From either flank projects a bank of some thirty oars, that look, as they smite the ocean with even beat, like the legs on which the reptile crawls over its surface. One stately mast of pine serves to carry a square sail made of cloth, brilliant with stripes of red, white, and blue.

And who are they who navigate this strange, barbaric vessel?—why leave they the sheltering fiords of their beloved Norway? They are the noblest hearts of that noble land—freemen, who value freedom,—who have abandoned all rather than call Harald master, and now seek a new home even among the desolate crags of Iceland, rather than submit to the tyranny of a usurper.

"Nord—oder Sud! wenn nur die Seelen gluben!"

Another picture, and a sadder story; but the scene is now a wide dun moor, on the slope of a seaward hill; the autumn evening is closing in, but a shadow darker than that of evening broods over the desolate plain,—the shadow of *Death*. Groups of armed men, with stern sorrow in their looks, are standing round a rude couch, hastily formed of fir branches. An old man lies there—dying. His ear is dulled even to the shout of victory; the mists of an endless night are gathering in his eyes; but there is passion yet in the quivering lip, and triumph on the high-resolved brow; and the gesture of his hand has kingly power still. Let me tell his saga, like the bards of that old time.

KING HACON'S LAST BATTLE.

I.

All was over: day was ending
As the foeman turned and fled.
Gloomy red
Glowed the angry sun descending;
While round Hacon's dying bed,
Tears and songs of triumph blending,
Told how fast the conqueror bled.

II.

"Raise me," said the King. We raised him
Not to ease his desperate pain;
That were vain!
"Strong our foe was—but we faced him:
Show me that red field again."
Then, with reverent hands, we placed him
High above the bloody plain.

III.

Silent gazed he; mute we waited,
Kneeling round—a faithful few,
Staunch and true,—

Whilst above, with thunder freighted,
Wild the boisterous north wind blew,
And the carrion-bird, unsated,
On slant wing around us flew.

IV.

Sudden, on our startled hearing,
Came the low-breathed, stern command—
"Lo! ye stand?
Linger not, the night is nearing;
Bear me downwards to the strand,
Where my ships are idly steering
Off and on, in sight of land."

V.

Every whispered word obeying,
Swift we bore him down the steep,
O'er the deep,
Up the tall ship's side, low swaying
To the storm-wind's powerful sweep,
And—his dead companions laying
Round him,—we had time to weep.

VI.

But the King said—"Peace! bring hither
Spoil and weapons—battle-strown,
Make no moan;
Leave me and my dead together,
Light my torch, and then—begone."
But we murmured, each to other,
"Can we leave him thus alone?"

VII.

Angrily the King replieth;
Flash the awful eyes again,
With disdain—
"Call him not *alone* who lieth
Low amidst such noble slain;
Call him not alone who dieth
Side by side with gallant men."

VIII.

Slowly, sadly, we departed:
Reached again that desolate shore,
Nevermore
Trod by him, the brave true-hearted—
Dying in that dark ship's core!
Sadder keel from land ne'er parted,
Nobler freight none ever bore!

IX.

There we lingered, seaward gazing,
Watching o'er that living tomb,
Through the gloom—
Gloom! which awful light is chasing—
Blood-red flames the surge illume!
Lo! King Hacon's ship is blazing;
'Tis the hero's self-sought doom.

X.

Right before the wild wind driving,
Madly plunging—stung by fire—
No help nigh her—
Lo! the ship has ceased her striving!
Mount the red flames higher—higher!
Till—on ocean's verge arriving,
Sudden sinks the Viking's pyre—
        Hacon's gone!

Let me call one more heroic phantom from Norway's romantic past.

A kindly presence, stately and tall; his shield held high above his head—a broken sword in his right hand. Olaf Tryggvesson! Founder of Nidaros;—that cold Northern Sea has rolled for many centuries above your noble head, and yet not chilled the battle heat upon your brow, nor staunched the blood that trickles down your iron glove, from hidden, untold wounds, which the tender hand of Thyri shall never heal!

To such ardent souls it is indeed given "to live forever" (the for ever of this world); for is it not "Life" to keep a hold on *our* affections, when their own passions are at rest, —to influence our actions (however indirectly)—when action is at an end for them? Who shall say how much of modern heroism may owe its laurels to that first throb of fiery sympathy which young hearts feel at the relation of deeds such as Olaf Tryggvesson's?

The forms of those old Greeks and Romans whom we are taught to reverence, may project taller shadows on the world's stage; but though the scene be narrow here, and light be wanting, the interest is not less intense, nor are the passions less awful that inspired these ruder dramas.

There is an individuality in the Icelandic historian's description of King Olaf that wins one's interest—at first as in an acquaintance—and rivets it at last as in a personal friend. The old Chronicle lingers with such loving minuteness over his attaching qualities, his social, generous nature, his gayety and "frolicsomeness;" even his finical taste in dress, and his evident proneness to fall too hastily in love, have a value in the portrait, as contrasting with the gloomy colors in which the story sinks at last. The warm, impulsive spirit speaks in every action of his life, from the hour when—a young child in exile—he strikes his axe into the skull of his foster father's murderer, to the last grand scene near Svälderöe. You trace it in his absorbing grief for the death of Geyra, the wife of this youth; the sage says, "he had no pleasure in Vinland after it," and then naïvely observes, "he *therefore* provided himself with war-ships, and went a-plundering," one of his first achievements being to go and pull down London Bridge. This peculiar kind of "distraction" (as the French call it) seems to have had the desired effect, as is evident in the romantic incident of his second marriage, when the Irish Princess Gyda chooses him—apparently an obscure stranger—to be her husband, out of a hundred wealthy and well-born aspirants to her hand. But neither Gyda's love, nor the rude splendors of her father's court, can make Olaf forgetful of his claims upon the throne of Norway—the inheritance of his father; and when that object of his just ambition is attained, and he is proclaimed King by general election of the Bonders, as his ancestor Harald Haarfager had been, his character deepens in earnestness as the sphere of his duties is enlarged. All the energies of his ardent nature are put forth in the endeavor to convert his subjects to the true Faith. As he himself expresses it, "he would bring it to this,—that all Norway should be Christian or *die!*" In the same spirit he meets his heretic and rebellious subjects at the Thing of Ladé, and boldly replies, when they require him to sacrifice to the false gods, "If I turn with you to offer sacrifice, then shall it be the greatest sacrifice that can be made; I will not offer slaves, nor malefactors to your gods,—I will sacrifice *men*;—and they shall be the noblest men among you!" It was soon after this that he despatched the exemplary Thangbrand to Iceland.

With a front not less determined does he face his country's foes. The king of Sweden, and Svend "of the forked beard," king of Denmark, have combined against him. With them is joined the Norse jarl, Eric, the son of Hacon. Olaf Tryggvesson is sailing homewards with a fleet of seventy ships,—himself commanding the famous "*Long Serpent*," the largest ship built in Norway. His enemies are lying in wait for him behind the islands.

Nothing can be more dramatic than the description of the sailing of this gallant fleet—(piloted by the treacherous Earl Sigwald)—within sight of the ambushed Danes and Swedes, who watch from their hiding-place the beautiful procession of hostile vessels, mistaking each in turn for the "*Long Serpent*," and as often undeceived by a new and yet more stately apparition. She appears at length, her dragon prow glittering in the sunshine, all canvas spread, her sides bristling with armed men; "and when they saw her, none spoke,—all knew it to be indeed the '*Serpent*,'—and they went to their ships to arm for the fight." As soon as Olaf and his forces had been enticed into the narrow passage, the united fleets of the three allies pour out of the Sound; his people beg Olaf to hold on his way and not risk battle with such a superior force; but the King replied, high on the quarter-deck where he stood, "Strike the sails! I never fled from battle: let God dispose of my life, but flight I will never take?" He then orders the war-horns to sound, for all his ships to close up to each other. "Then," says Ulf the Red, captain of the forecastle, "if the '*Long Serpent*' is to lie so much a-head of the other vessels, we shall have hot work of it here on the forecastle."

The King replies, "I did not think I had a forecastle man *afraid*, as well as *red*."[1]

Says Ulf, "Defend thou the quarter-deck, as I shall the forecastle."

The King had a bow in his hands; he laid an arrow on the string, and made as if he aimed at Ulf.

Ulf said, "Shoot another way, King, where it is more needful,—my work is thy gain."

Then the King asked, "Who is the chief of the force right opposite to us?" He is answered, "Svend of Denmark, with his army."

Olaf replies, "We are not afraid of these soft Danes! Who are the troops on the right?"

They answer, "Olaf of Sweden, and his forces."

"Better it were," replies the King, "for these Swedes to be sitting at home, killing their sacrifices, than venturing under the weapons of the '*Long Serpent.*' But who owns the large ships on the larboard side of the Danes?"

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[1] There is a play on these two words in the Icelandic, "Raudan oc Ragan."

"That is Jarl Eric, son of Hacon," say they.

The King says, "*He* has reason for meeting us; we may expect hard blows from these men; they are Norsemen like ourselves."

The fierce conflict raged for many hours. It went hard with the "soft Danes," and idolatrous Swedes, as Olaf had foreseen; after a short struggle they turn and fly. But Jarl Eric in his large ship the "*Iron Beard*" is more than a match for Olaf's lighter vessels. One by one their decks are deluged with blood, their brave defenders swept into the sea; one by one they are cut adrift and sent loose with the tide. And now at last the "*Iron Beard*" lies side by side with the "*Long Serpent*," and it is indeed "hot work" both on forecastle and quarter-deck.

"Einar Tambarskelvar, one of the sharpest of bowmen, stood by the mast, and shot with his bow." His arrow hits the tiller-end, just over the Earl's head, and buries itself up to the shaft in the wood. "Who shot that bolt?" says the Jarl. Another flies between his hand and side, and enters the stuffing of the chief's stool. Then said the Jarl to a man named Fin, "Shoot that tall archer by the mast!" Fin shoots; the arrow hits the middle of Einar's bow as he is in the act of drawing it, and the bow is split in two.

"What is that," cried King Olaf, "that broke with such a noise?"

"*Norway*, King, from thy hands!" cried Einar.

"No! not so much as that," says the King; "take my bow, and shoot,"—flinging the bow to him.

Einar took the bow, and drew it over the head of the arrow. "Too weak, too weak," said he, "for the bow of a mighty King!" and throwing the bow aside, "he took sword and buckler, and fought valiantly."

But Olaf's hour is come. Many slain lie around him: many that have fallen by his hand, more that have fallen at his side. The thinned ranks on board the "*Iron Beard*" are constantly replenished by fresh combatants from other vessels, even by the Swedes and soft Danes, now "strong, upon the stronger side,"—while Olaf, cut off from succor, stands almost alone upon the "*Serpent's*" deck, made slippery by his people's blood. The Jarl had laid out boats to intercept all who might escape from the ship; but escape is not in the King's thoughts. He casts one look around him, glances at his sword—broken like Einar's bow—draws a deep breath, and, holding his shield above his head, springs overboard. A shout—a rush! who shall first grasp that noble prisoner? Back, slaves! the shield that has brought him scathless through a hundred fights, shall yet shelter him from dishonor.

Countless hands are stretched to snatch him back to worthless life, but the shield alone floats on the swirl of the wave:—King Olaf has sunk beneath it.

Perhaps you have already had enough of my Saga lore; but with that grey cathedral full in sight, I cannot but dedicate a few lines to another Olaf, king and warrior like the last, but to whom after times have accorded a yet higher title.

Saint Olaf's—Saint Olave, as we call him—early history savors little of the odor of sanctity, but has rather that "ancient and fish-like smell" which characterized the doings of the Vikings, his ancestors. But those were days when honor rather than disgrace attached to the ideas of booty and plunder, especially in an enemy's country; it was a "spoiling of the Egyptians" sanctioned by custom, and even permitted by the Church, which did not disdain occasionally to share in the profits of a successful cruise, when presented in the decent form of silver candlesticks and other ecclesiastical gauds. As to the ancient historian, he mentions these matters as a thing of course. "Here the King landed, burnt, and ravaged;" "there the Jarl gained much booty;" "this summer, they took a cruise in the Baltic, to gather property," etc., much as a modern biographer would speak of a gentleman's successful railroad speculations, his taking shares in a coal mine, or coming into a "nice little thing in the Long Annuities." Nevertheless, here is something significant of his future vocation, in a speech which Olaf makes to his assembled friends and relations, imparting to them his design of endeavoring to regain possession of the throne: "I and my men have nothing for our support save what we captured in war, *for which we have hazarded both life and soul;* for many an innocent man have we deprived of his property, and some of their lives, and foreigners are now sitting in the possessions of my fathers." One sees here a faint glimmer of the Saint's nimbus, over the helmet of the Viking, a dawning perception of the "rights of property," which, no doubt, must have startled his hearers into the most ardent conservative zeal for the good old marauding customs.

But though years elapsed, and fortunes changed, before this dim light of the early Church became that scorching and devouring flame which, later, spread terror and confusion among the haunts of the still lingering ancient gods, an earnest sense of duty seems to have been ever present with him. If it cannot be denied that he shared the errors of other proselytizing monarchs, and put down Paganism with a stern and bloody hand, no merely personal injury ever weighed with him. How grand is his reply to those who advise him to ravage with fire and sword the rebellious district of Throndhjem, as he had formerly punished numbers of his subjects who had rejected Christianity:—"We had then *God's* honor to defend; but this treason against their sovereign is a much less grievous crime; it is more in my power to spare those who have dealt ill with me, than those whom God hated." The same hard measure which he meted to others he applied to his own actions; witness that curiously characteristic scene, when, sitting in his high seat, at table, lost in thought, he begins unconsciously to cut splinters from a piece of fir-wood which he held in his hand. The table servant seeing what the King was about, says to him (mark the respectful periphrasis!), "*It is Monday, Sire, to-morrow.*" The King looks at him, and it came into his mind what he was doing on a Sunday. He sweeps up the shavings he had made, set fire to them, and lets them burn on his naked hand; "showing thereby that he would hold fast by God's law, and not trespass without punishment."

But whatever human weakness may have mingled with the pure ore of this noble character, whatever barbarities may have stained his career, they are forgotten in the pathetic close of his martial story.

His subjects—alienated by the sternness with which he administers his own severely religious laws, or corrupted by the bribes of Canute, King of Denmark and England—are fallen from their allegiance. The brave, single-hearted monarch is marching against the rebellious Bonders, at the head of a handful of foreign troops, and such as remained faithful among his own people. On the eve of that last battle, on which he stakes throne and life, he intrusts a large sum of money to a Bonder, to be laid out "on churches, priests, and almsmen, as gifts for the souls of such as may fall in battle *against himself*,"—strong in the conviction of the righteousness of his cause, and the assured salvation of such as upheld it.

He makes a glorious end. Forsaken by many whom he had loved and served, yet forgiving and excusing them; rejecting the aid of all who denied that holy Faith which had become the absorbing interest of his life,—but surrounded by a faithful few, who share his fate; "in the lost battle, borne down by the flying"—he falls, transpierced by many wounds, and the last words on his fervent lips are prayer to God.[1]

Surely there was a gallant saint and soldier. Yet he was not the only one who bore himself nobly on that day. Here is another episode of that same fatal fight.

A certain Thormod is one of the Scalds (or Poets) in King Olaf's army. The night before the battle he sings a spirited song at the King's request, who gives him a gold ring from his finger in token of his approval. Thormod thanks him for the gift, and says, "It is my prayer, Sire, that we shall never part, either in life or death." When the King receives his death-wound Thormod is near him,—but, wounded himself, and so weak and weary that in a desperate onslaught by the King's men, — nicknamed "*Dag's storm,*"—*he only stood by his comrade in the ranks, although he could do nothing.*

The noise of the battle has ceased; the King is lying dead where he fell. The very man who had dealt him his death-wound has laid the body straight out on the ground, and spread a cloak over it. "And when he wiped the blood from the face it was very beautiful, and there was red in the cheeks, as if he only slept."

Thormod, who had received a second wound as he stood in the ranks—(an arrow in his side, which he breaks off at the shaft),—wanders away towards a large barn, where other wounded men have taken refuge. Entering with his drawn sword in his hand, he meets one of the Bonders coming out, who says, "It is very bad there, with howling and screaming; and a great shame it is, that brisk young fellows cannot bear their wounds. The King's men may have done bravely to-day, but truly they bear their wounds ill."

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[1] The exact date of the battle of Sticklestad is known: an eclipse of the sun occurred while it was going on.

Thormod asks what his name is, and if he was in the battle. Kimbe was his name, and he had been "with the Bonders, which was the best side." "And hast thou been in the battle too?" asks he of Thormod.

Thormod replies, "I was with them that had the best."

"Art thou wounded?" says Kimbe.

"Not much to signify," says Thormod.

Kimbe sees the gold ring, and says, "Thou art a King's man: give me thy gold ring, and I will hide thee."

Thormod replies, "Take the ring if thou canst get it; *I have lost that which is more worth*."

Kimbe stretches out his hand to seize the ring; but Thormod, swinging his sword, cuts off his hand; and it is related, that Kimbe behaved no better under his wound than those he had just been blaming."

Thormod then enters the house where the wounded are lying, and seats himself in silence by the door.

As the people go in and out, one of them casts a look at Thormod, and says, "Why art thou so dead pale? Art thou wounded?" He answers carelessly, with a half-jesting rhyme, then rises and stands awhile by the fire. A woman, who is attending on those who are hurt, bids him "go out, and bring in firewood from the door." He returns with the wood, and the girl then looking him in the face, says, "Dreadfully pale is this man;" and asks to see his wounds. She examines his wound in his side, and feels that the iron of the arrow is still there; she then takes a pair of tongs and tries to pull it out, "but it sat too fast, and as the wound was swelled, little of it stood out to lay hold of." Thormod bids her "cut deep enough to reach the iron, and then to give him the tongs, and let him pull." She did as he bade. He takes the ring from his hand, and gives it to the girl, saying, "It is a good man's gift! King

Olaf gave it to me this morning." Then Thormod took the tongs and pulled the iron out. The arrow-head was barbed, and on it there hung some morsels of flesh. When he saw that he said, "*The King has fed us well!* I am fat, even at the heart-roots!" And so saying, he leant back, and died.[1]

Stout, faithful heart! if they gave you no place in your master's stately tomb, there is room for you by his side in heaven!

I have at last received—I need not say how joyfully—two letters from you; one addressed to Hammerfest. I had begun to think that some Norwegian warlock had bewitched the post-bags, in the approved old ballad fashion, to prevent their rendering up my dues; for when the packet of letters addressed to the "*Foam*" was brought on board, immediately after our arrival, I alone got nothing. From Sigurdr and the Doctor to the cabin-boy, every face was beaming over "news from home!" while I was left to walk the deck, with my hands in my pockets, pretending not to care. But the spell is broken now, and I retract my evil thoughts of the warlock and you.

Yesterday we made an excursion as far as Ladé, saw a waterfall, which is one of the lions of this neighborhood (but a very mitigated lion, which "roars you as soft as any sucking dove"), and returned in the evening to attend a ball given to celebrate the visit of the Crown Prince.

At Ladé, I confess I could think of nothing but "the great Jarl" Hacon, the counsellor, and maker of kings, king himself in all but the name, for he ruled over the western sea-board of Norway, while Olaf Tryggvesson was yet a wanderer and exile. He is certainly one of the most picturesque figures of these Norwegian dramas; what with his rude wit, his personal bravery, and that hereditary beauty of his race for which he was conspicuous above the rest. His very errors, great as they were, have a dash and prestige about them, which in that rude time must have dazzled men's eyes, and especially *women's* as his story proves. It was his sudden passion for the beautiful Gudrun Lyrgia (the "Sun of Lunde," as she was called), which precipitated the avenging fate which years of heart-burnings and discontent among his subjects had been preparing. Gudrun's husband incites the Bonders to throw off the yoke of the licentious despot,—Olaf Tryggvesson is proclaimed king,—and the "great Jarl of Ladé" is now a fugitive in the land he so lately ruled, accompanied by a single thrall, named Karker.

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[1] When a man was wounded in the abdomen, it was the habit of the Norse leeches to give him an onion to eat; by this means they learnt whether the weapon had perforated the viscera.

In this extremity, Jarl Hacon applies for aid to Thora of Rimmol, a lady whom he had once dearly loved: she is faithful in adversity to the friend of happier days, and conceals the Jarl and his companion in a hole dug for this purpose, in the swine-stye, and covered over with wood and litter; as the only spot likely to elude the hot search of his enemies. Olaf and the Bonders seek for him in Thora's house, but in vain; and finally, Olaf, standing on the very stone against which the swine-stye is built, promises wealth and honors to him who shall bring him the Jarl of Ladé's head. The scene which follows is related by the Icelandic historian with Dante's tragic power.

There was a little daylight in their hiding-place, and the Jarl and Karker both hear the words of Olaf.

"Why art thou so pale?" says the Jarl, "and now again as black as earth? Thou dost not mean to betray me?"

"By no means," said Karker.

"We were born on the same night," said the Jarl, "and the time will not be long between our deaths."

When night came, the Jarl kept himself awake; but

Karker slept;—a troubled sleep. The Jarl awoke him, and asked of what he was dreaming. He answered, "I was at Ladé, and Olaf was laying a gold ring about my neck."

The Jarl said, "It will be a *red* ring about thy neck, if he catches thee: from me thou shalt enjoy all that is good,—therefore, betray me not!"

Then they both kept themselves awake; "*the one, as it were, watching upon the other.*" But towards day, the Jarl dropped asleep, and in his unquiet slumber he drew his heels under him, and raised his neck as if going to rise, "and shrieked fearfully." On this, Karker, "dreadfully alarmed," drew a knife from his belt, stuck it into the Jarl's throat, and cut off his head. Late in the day he came to Ladé, brought the Jarl's head to Olaf, and told his story.

It is a comfort to know that "*the red ring*" was laid round the traitor's neck: Olaf caused him to be beheaded.

What a picture that is, in the swine-stye, those two haggard faces, travel-stained and worn with want of rest, watching each other with hot, sleepless eyes through the half darkness, and how true to nature is the nightmare of the miserable Jarl!

It was on my return from Ladé, that I found your letters; and that I might enjoy them without interruption, I carried them off to the churchyard—(such a beautiful place!)—to read in peace and quiet. The churchyard was *not* "populous with young men, striving to be alone," as Tom Hood describes it to have been in a certain sentimental parish; so I enjoyed the seclusion I anticipated.

I was much struck by the loving care and ornament bestowed on the graves; some were literally loaded with flowers, and even those which bore the date of a long past sorrow had each its own blooming crown, or fresh nosegay. These good Throndhjemers must have much of what the French call *la religion des souvenirs*, a religion in which we

English (as a nation) are singularly deficient. I suppose no people in Europe are so little addicted to the keeping of sentimental anniversaries as we are; I make an exception with regard to our living friends' birthdays, which we are ever tenderly ready to cultivate, when called on; turtle, venison, and champagne, being pleasant investments for the affections. But time and business do not admit of a faithful adherence to more sombre reminiscences; a busy gentleman "on 'Change" cannot conveniently shut himself up, on his "lost Araminta's natal-day," nor will a railroad committee allow of his running down by the 10.25 A. M., to shed a tear over that neat tablet in the new Willow-cum-Hatband Cemetery. He is necessarily content to regret his Araminta in the gross, and to omit the petty details of a too pedantic sorrow.

The fact is, we are an eminently practical people, and are easily taught to accept "the irrevocable," if not without regret, at least with a philosophy which repudiates all superfluous methods of showing it. *Decent* is the usual and appropriate term applied to our churchyard solemnities, and we are not only "content to dwell in decencies for ever," but to die, and be buried in them.

The cathedral loses a little of its poetical physiognomy on a near approach. Modern restoration has done something to spoil the outside, and modern refinement a good deal to degrade the interior with pews and partitions; but it is a very fine building, and worthy of its metropolitan dignity. I am told that the very church built by Magnus the Good—son of Saint Olave—over his father's remains, and finished by his uncle Harald Hardrada, is, or rather was, included in the walls of the cathedral; and though successive catastrophes by fire have perhaps left but little of the original building standing, I like to think that some of these huge stones were lifted to their place under the eyes of Harald the Stern. It was on the eve of his last fatal expedition against our own Harold of England that the shrine of St. Olave was opened by the King, who, having clipped the hair and nails of the dead saint (most probably as relics, efficacious for the protection of himself and followers), then locked the shrine, and threw the keys into the Nid. Its secrets from that day were respected until the profane hands of Lutheran Danes carried it bodily away, with all the gold and silver chalices, and jewelled pyxes, which, by kingly gifts and piratical offerings, had accumulated for centuries in its treasury.

He must have been a fine, resolute fellow, that Harald the Stern, although, in spite of much church-building and a certain amount of Pagan-persecuting, his character did not in any way emulate that of his saintly brother. The early part of his history reads like a fairy tale, and is a favorite subject for Scald songs ; more especially his romantic adventures in the East,—

> " Well worthy of the golden prime
> Of good Haroun Alraschid ; "

where Saracens flee like chaff upon the wind before him, and impregnable Sicilian castles fall into his power by impossible feats of arms, or incredible stratagems. A Greek empress, " the mature Zoe," as Gibbon calls her, falls in love with him, and her husband, Constantine Monomachus, puts him in prison ; but Saint Olaf still protects his *mauvais sujet* of a brother, and inspires " a lady of distinction" with the successful idea of helping Harald out of his inaccessible tower by the prosaic expedient of a ladder of ropes. A boom, however, across the harbor's mouth still prevents the escape of his vessel. The Sea-king is not to be so easily baffled. Moving all his ballast, arms, and men into the afterpart of the ship, until her stem slants up out of the sea, he rows straight at the iron chain. The ship leaps almost half-way over. The weight being then immediately transferred to the fore-part, the ship slips down into the water on the other side; having topped the fence like an Irish hunter. A second galley breaks her back in the attempt. After some questionable acts of vengeance on the Greek court, Harald and his bold Væringers go fighting and plundering their way through the Bosphorus and Black Sea back to Novogorod, where the first part of the romance terminates, as it should, by his marriage with the object of his secret attachment, Elisof, the daughter of the Russian king.

Hardrada's story darkens towards the end, as most of the tales of that stirring time are apt to do. His death on English ground is so striking, that you must have patience with one other short Saga: it will give you the battle of Stanford Bridge from the Norse point of view.

The expedition against Harold of England commences ill; dreams and omens affright the fleet; one man dreams he sees a raven sitting on the stern of each vessel; another sees the fair English coast;

"But glancing shields
Hide the green fields;"

and other fearful phenomena mar the beautiful vision. Harald himself dreams that he is back again at Nidaros, and that his brother Olaf meets him with a prophecy of ruin and death. The bold Norsemen are not to be daunted by these auguries, and their first successes on the English coast seem to justify their persistence. But on a certain beautiful Monday in September (A. D. 1066, according to the Saxon Chronicle), part of his army being encamped at Stanford Bridge, "Hardrada, *having taken breakfast*, ordered the trumpets to sound for going on shore;" but he left half his force behind, to guard the ships: and his men, anticipating no resistance from the castle, which had already surrendered, "went on shore (the weather being hot), with only their helmets, shields, and spears, and girt with swords; some had bows and arrows,—and all were very merry." On nearing the castle, they see "a cloud of dust as from horses' feet, and under it shining shields and bright armor." English Harold's army is before them. Hardrada sends back to his ship for succor, and sets up his banner, "Land Ravager," undismayed by the inequality of his force, and their comparatively unarmed condition. The men on each side are drawn up in battle array, and the two kings in presence; each gazes eagerly to discover his noble foe among the multitude. Harald Hardrada's black horse stumbles and falls; "the King got up in haste, and said, 'A fall is lucky for a traveller.'"

The English King said to the Northmen who were with him, "Do you know the stout man who fell from his horse, with the blue kirtle, and beautiful helmet?"

"That is the Norwegian King," said they.

English Harold replied, "A great man, and of stately appearance is he; but I think his luck has left him."

And now twenty gallant English knights ride out of their ranks to parley with the Northmen. One advances beyond the rest and asks if Earl Toste, the brother of English Harold (who has banded with his enemy against him), is with the army.

The Earl himself proudly answers, "It is not to be denied that you will find him here."

The Saxon says, "Thy brother, Harold, sends his salutation, and offers thee the third part of his kingdom, if thou wilt be reconciled and submit to him."

The Earl replies, at the suggestion of the Norse King, "What will my brother the King give to Harald Hardrada for his trouble?"

"He will give him," says the Knight, "*seven feet of English ground, or as much more as he may be taller than other men.*"

"Then," says the Earl, "let the English King, my brother, make ready for battle, for it never shall be said that Earl Toste broke faith with his friends when they came with him to fight west here in England."

When the knights rode off, King Harald Hardrada asked the Earl, "Who was the man who spoke so well?"

The Earl replied, "That knight was Harold of England."

The stern Norwegian King regrets that his enemy had escaped from his hands, owing to his ignorance of this fact; but even in his first burst of disappointment, the noble Norse nature speaks in generous admiration of his foe, saying to the people about him, "That was but a little man, yet he sat firmly in his stirrups."

The fierce but unequal combat is soon at an end; and when tardy succor arrives from the ships, Harald Hardrada is lying on his face, with the deadly arrow in his throat, never to see Nidaros again. Seven feet of English earth, and no more, has the strong arm and fiery spirit conquered.

But enough of these gallant fellows; I must carry you off to a much pleasanter scene of action. After a very agreeable dinner with Mr. K——, who has been most kind to us, we adjourned to the ball. The room was large and well lighted—plenty of pretty faces adored it;—the floor was smooth, and the scrape of the fiddles had a festive accent so extremely inspiriting, that I besought Mr. K—— to present me to one of the fair personages whose tiny feet were already tapping the floor with impatience at their own inactivity.

I was led up in due form to a very pretty lady, and heard my own name, followed by a singular sound purporting to be that of my charming partner, Madame Hghelghghagllaghem. For the pronunciation of this polysyllabic cognomen, I can only give you a few plain instructions;

commence it with a slight cough, continue with a gurgling in the throat, and finish with the first convulsive movement of a sneeze, imparting to the whole operation a delicate nasal twang. If the result is not something approaching to the sound required, you must relinquish all hope of achieving it, as I did. Luckily, my business was to dance, and not to apostrophize the lady; and accordingly, when the waltz struck up, I hastened to claim, in the dumbest show, the honor of her hand. Although my dancing qualifications have rather rusted during the last two or three years, I remembered that the time was not so very far distant when even the fair Mad$^{elle.}$ E—— had graciously pronounced me to be a very tolerable waltzer, "for an Englishman," and I led my partner to the circle already formed with the "*air capable*" which the object of such praise is entitled to assume. There was a certain languid rhythm in the air they were playing which rather offended my ears, but I suspected nothing until, observing the few couples who had already descended into the arena, I became aware that they were twirling about with all the antiquated grace of "*la valse à trois temps*." Of course my partner would be no exception to the general rule! nobody had ever danced anything else at Throndhjem from the days of Odin downwards; and I had never so much as attempted it. What was to be done? I could not explain the state of the case to Madame Hghelghghagllaghem: she could not understand English, nor I speak Norse. My brain reeled with anxiety to find some solution of the difficulty, or some excuse for rushing from her presence. What if I were taken with a sudden bleeding at the nose, or had an apopletic fit on the spot? Either case would necessitate my being carried decently out, and consigned to oblivion, which would have been a comfort, under the circumstances. There was nothing for it but the courage of despair; so, casting reflection to the winds, and my arm round her waist, I suddenly whisked her off her legs, and dashed madly down the room, "*à deux temps*." At the first perception that something unusual was going on, she gave such an eldritch scream, that the whole society suddenly came to a standstill. I thought it best to assume an aspect of innocent composure and conscious rectitude; which had its effect, for though the lady began with a certain degree of hysterical animation to describe her wrongs, she finished with a hearty laugh, in which the company cordially joined, and I delicately chimed in. For the rest of the dance she seemed to resign herself to her fate, and floated through space, under my guidance, with all the *abandon* of Francesca di Rimini, in Scheffer's famous picture.

The Crown Prince is a tall, fine-looking person: he was very gracious, and asked many questions about my voyage.

At night there was a general illumination, to which the "*Foam*" contributed some blue lights.

We got under way early this morning, and without a pilot—as we had entered—made our way out to sea again. I left Throndhjem with regret, not for its own sake, for in spite of balls and illuminations I should think the pleasures of a stay there would not be deliriously exciting; but this whole district is so intimately associated in my mind with all the brilliant episodes of ancient Norwegian History, that I feel as if I were taking leave of all those noble Haralds, and Olafs, and Hacons, among whom I have been living in such pleasant intimacy for some time past.

While we are dropping down the coast, I may as well employ the time in giving you a rapid sketch of the commencement of this fine Norse people, though the story "*remonte jusqu'à la nuit des temps*," and has something of the vague magnificence of your own M'Donnell genealogy, ending a long list of great potentates, with "somebody, who was the son of somebody else, who was the son of Scotha, who was the daughter of Pharaoh!"

In by-gone ages, beyond the Scythian plains and the fens of the Tanaïs, in that land of the morning, to which neither Grecian letters nor Roman arms had ever penetrated, there was a great city called Asgaard. Of its founder, of its history, we know nothing; but, looming through the mists of antiquity, we can discern an heroic figure, whose superior attainments won for him the lordship of his own generation, and divine honors from those that succeeded. Whether moved by an irresistible impulse, or impelled by more powerful neighbors, it is impossible to say; but certain it is that at some period, not perhaps very long before the Christian era, under the guidance of this personage, a sun-nurtured people moved across the face of Europe, in a north-westerly direction, and after leaving settlements along the southern shores of the Baltic, finally established themselves in the forests and valleys of what has come to be called the Scandinavian Peninsula. That children of the South should have sought out so inclement a habitation may excite surprise; but it must always be remembered that they were, probably, a comparatively scanty congregation, and that the unoccupied valleys of Norway and Sweden, teeming with fish and game, and rich in iron, were a preferable region to lands only to be colonised after they had been conquered.

Thus, under the leadership of Odin and his twelve Paladins,—to whom a grateful posterity afterwards conceded thrones in the halls of their chief's Valhalla,—the new emigrants spread themselves along the margin of the outocean, and round about the gloomy fiords, and up and down the deep valleys that fall away at right angles from the backbone, or *keel*, as the seafaring population soon learnt to call the flat, snow-capped ridge that runs down the centre of Norway.

Amid the rude but not ungenial influences of its bracing climate, was gradually fostered that gallant race which was destined to give an imperial dynasty to Russia, a nobility to England, the conquerors to every sea-board in Europe.

Upon the occupation of their new home, the ascendency of that mysterious hero, under whose auspices the settlement was conducted, appears to have remained more firmly established than ever, not only over the mass of the people, but also over the twelve surbordinate chiefs who accompanied him; there never seems to have been the slightest attempt to question his authority, and, though afterwards themselves elevated into an order of celestial beings, every tradition which has descended is careful to maintain his human and divine supremacy. Through the obscurity, the exaggeration, and the ridiculous fables, with which his real existence has been overloaded, we can still see that this man evidently possessed a genius as superior to his contemporaries, as has ever given to any child of man the ascendency over his generation. In the simple language of the old chronicler, we are told, " that his countenance was so beautiful that when sitting among his friends, the spirits of all were exhilarated by it; that when he spoke, all were persuaded; that when he went forth to meet his enemies, none could withstand him." Though subsequently made a god by the superstitious people he had benefitted, his death seems to have been noble and religious. He summoned his friends around his pillow, intimated a belief in the immortality of his soul, and his hope that hereafter they should meet again in Paradise. "Then," we are told, "began the belief in Odin, and their calling upon him."

On the settlement of the country, the land was divided and subdivided into lots—some as small as fifty acres—and each proprietor held his share—as their descendants do to this day—by udal right; that is, not as a fief of the Crown, or of any superior lord, but in absolute, inalienable possession, by the same udal right as the kings wore their crowns, to be transmitted, under the same title, to their descendants unto all generations.

These landed proprietors were called the Bonders, and formed the chief strength of the realm. It was they, their friends and servants, or thralls, who constituted the army. Without their consent the king could do nothing. On stated occasions they met together, in solemn assembly, or Thing, (*i.e.* Parliament,) as it was called, for the transaction of public business, the administration of justice, the allotment of the scatt, or taxes.

Without a solemn induction at the Ore or Great Thing, even the most legitimately-descended sovereign could not mount the throne, and to that august assembly an appeal might ever lie against his authority.

To these Things, and to the Norse invasion that implanted them, and not to the Wittenagemotts of the Latinized Saxons, must be referred the existence of those Parliaments which are the boast of Englishmen.

Noiselessly and gradually did a belief in liberty, and an unconquerable love of independence, grow up among that simple people. No feudal despots oppressed the unprotected, for all were noble and udal born ; no standing armies enabled the Crown to set popular opinion at defiance, for the swords of the Bonders sufficed to guard the realm ; no military barons usurped an illegitimate authority, for the nature of the soil forbade the erection of feudal fortresses. Over the rest of Europe despotism rose up rank under the tutelage of a corrupt religion ; while, year after year, amid the savage scenery of its Scandinavian nursery, that great race was maturing whose genial heartiness was destined to invigorate the sickly civilization of the Saxon with inexhaustible energy, and preserve to the world, even in the nineteenth century, one glorious example of a free European people.

LETTER XIII.

COPENHAGEN—BERGEN—THE BLACK DEATH—SIGURDR—HOMEWARDS.

COPENHAGEN, Sept. 12th, 1856.

OUR adventures since the date of my last letter have not been of an exciting character. We had fine weather and prosperous winds down the coast, and stayed a day at Christiansund, and another at Bergen. But though the novelty of the cruise had ceased since our arrival in lower latitudes, there was always a certain raciness and oddity in the incidents of our coasting voyage; such as—waking in the morning, and finding the schooner brought up under the lee of a wooden house, or—riding out a foul wind with your hawser rove through an iron ring in the sheer side of a mountain,—which took from the comparative flatness of daily life on board.

Perhaps the queerest incident was a visit paid us at Christiansund. As I was walking the deck I saw a boat coming off, with a gentleman on board; she was soon along-side the schooner, and as I was gazing down on this individual, and wondering what he wanted, I saw him suddenly lift his feet lightly over the gunwale and plunge them into the water, boots and all. After cooling his heels in this way for a minute or so, he laid hold of the side ropes and gracefully swung himself on deck. Upon this, Sigurdr, who always acted interpreter on such occasions, advanced towards him, and a colloquy followed, which terminated rather abruptly in Sigurdr walking aft, and the web-footed stranger ducking down into his boat again. It was not till some hours later that the indignant Sigurdr explained the meaning of the visit. Although not a naval character, this gentleman certainly came into the category of men "who do business in great waters," his *business* being to negotiate a loan; in short, to ask me to lend him £100. There must have been something very innocent and confiding in "the cut of our jib" to encourage his boarding us on such an errand; or perhaps it was the old marauding, toll-taking spirit coming out strong in him: the politer influences of the nineteenth century toning down the ancient Viking into a sort of a cross between Paul Jones and Jeremy Diddler. The seas which his ancestors once swept with their galleys, he now sweeps with his telescope, and with as keen an eye to the *main* chance as any of his predecessors displayed. The feet-washing ceremony was evidently a propitiatory homage to the purity of my quarter-deck.

Bergen, with its pale-faced houses grouped on the brink of the fiord, like invalids at a German Spa, though picturesque in its way, with a cathedral of its own, and plenty of churches, looked rather tame and spiritless after the warmer coloring of Throndhjem; moreover it wanted novelty to me, as I called in there two years ago on my return from the Baltic. It was on that occasion that I became possessed of my ever-to-be-lamented infant walrus.

No one, personally unacquainted with that "most delicate monster," can have any idea of his attaching qualities. I own that his figure was not strictly symmetrical; that he had a roll in his gait, suggestive of heavy seas; that he would not have looked well in your boudoir: but he never seemed out of place on my quarter-deck, and every man on board loved him as a brother. With what a languid grace he would wallow and roll in the water, when we chucked him overboard; and paddle and splash, and make himself thoroughly cool and comfortable, and then come and "beg to be taken up," like a fat baby, and allow the rope to be slipped round his extensive waist, and come up—sleek and dripping—among us again with a contented grunt, as much as to say, "Well, after all, there's no place like *home!*" How he would compose himself to placid slumber in every possible inconvenient place, with his head on the binnacle (especially when careful steering was a matter of moment), or across the companion entrance, or the cabin skylight, or on the shaggy back of "Sailor," the Newfoundland, who positively abhorred him. But how touching it was to see him waddle up and down the deck after Mr. Wyse, whom he evidently regarded in a maternal point of view—begging for milk with the most expressive snorts and grunts, and embarrassing my good-natured master by demonstrative appeals to his fostering offices!

I shall never forget Mr. Wyse's countenance that day in Ullapool Bay, when he tried to command his feelings sufficiently to acquaint me with the creature's death, which he announced in this graphic sentence, "Ah, my Lord!—the poor thing!—*toes up at last!*"

Bergen is not as neat and orderly in its architectural arrangements as Drontheim; a great part of the city is a confused network of narrow streets and alleys, much resembling, I should think, its early inconveniences, in the days of Olaf Kyrre. This close and stifling system of street building must have ensured fatal odds against the chances of life in some of those world-devastating plagues that characterize past ages. Bergen was, in fact, nearly depopulated by that terrible pestilence which, in 1349, ravaged the North of Europe, and whose memory is still preserved under the name of "The Black Death."

I have been tempted to enclose you a sort of ballad, which was composed while looking on the very scene of this disastrous event; its only merit consists in its local inspiration, and in its conveying a true relation of the manner in which the plague entered the doomed city.

THE BLACK DEATH OF BERGEN.

I.

WHAT can ail the Bergen Burghers
  That they leave their stoups of wine ?
Flinging up the hill like jägers,
  At the hour they're wont to dine !
See, the shifting groups are fringing
  Rock and ridge with gay attire,
Bright as Northern streamers tinging
  Peak and crag with fitful fire !

II.

Towards the cliff their steps are bending,
  Westward turns their eager gaze,
Whence a stately ship ascending,
  Slowly cleaves the golden haze.
Landward floats the apparition—
  "Is it, *can* it be the same ?"
Frantic cries of recognition
  Shout a long-lost vessel's name !

III.

Years ago had she departed—
  Castled poop and gilded stern ;
Weeping women, broken-hearted,
  Long had waited her return.
When the midnight sun wheeled downwards,
  But to kiss the ocean's verge—
When the noonday sun, a moment
  Peeped above the Wintry surge,

IV.

Childless mothers, orphaned daughters,
  From the seaward-facing crag,
Vainly searched the vacant waters
  For that unreturning flag !
But, suspense and tears are ended,
  Lo ! it floats upon the breeze !
Ne'er from eager hearts ascended
  Thankful prayers as warm as these

V.

See the good ship proudly rounding
  That last point that blocks the view;
"Strange! no answering cheer resounding
  From the long home-parted crew!"
Past the harbor's stony gateway,
  Onwards borne by sucking tides,
Tho' the light wind faileth—straightway
  Into port she safely glides.

VI.

Swift, as by good angels carried,
  Right and left the news has spread,
Wives long widowed—yet scarce married—
  Brides that never hoped to wed,
From a hundred pathways meeting
  Crowd along the narrow quay,
Maddened by the hope of meeting
  Those long counted cast away.

VII.

Soon a crowd of small boats flutter
  O'er the intervening space,
Bearing hearts too full to utter
  Thoughts that flush the eager face!
See young Eric foremost gaining—
  (For a father's love athirst!)
Every nerve and muscle straining,
  But to touch the dear hand *first*.

VIII.

In the ship's green shadow rocking
  Lies his little boat at last:
Wherefore is the warm heart knocking
  At his side, so loud and fast?
"What strange aspect is she wearing,
  Vessel once so taut and trim?
Shout!—*my* heart has lost its daring;
  Comrades, search!—*my* eyes are dim.

IX.

Sad the search, and fearful finding!
  On the deck lay parched and dry
Men—who in some burning, blinding
  Clime—had laid them down to die!
Hands—prayer-clenched—that would not sever,
  Eyes that stared against the sun,
Sighs that haunt the soul for ever,
  Poisoning life—till life is done!

X.

Strength from fear doth Eric gather,
  Wide the cabin door he threw—
Lo! the face of his dead father,
  Stern and still, confronts his view!
Stately as in life he bore him,
  Seated—motionless and grand;
On the blotted page before him
  Lingers still the livid hand!

XI.

What sad entry was he making,
  When the death-stroke fell at last?
"Is it then God's will, in taking
  All, that I am left the last?
I have closed the cabin doorway,
  That I may not see them die:—
Would our bones might rest in Norway,—
  'Neath our own cool Northern sky!"

XII.

Then the ghastly log-book told them
  How—in some accursed clime,
Where the breathless land-swell rolled them,
  For an endless age of time—
Sudden broke the plague among them,
  'Neath that sullen Tropic sun;
As if fiery scorpions stung them—
  Died they raving, one by one!

XIII.

Told the vain and painful striving,
By shot-weighted shrouds to hide
(Last fond care), from those surviving,
What good comrade last had died;
Yet the ghastly things kept showing,
Waist deep in the unquiet grave—
To each other gravely bowing
On the slow swing of the wave!

XIV.

Eric's boat is near the landing—
From that dark ship bring they aught?
In the stern sheets *one* is standing,
Though their eyes perceive him not;
But a curdling horror creepeth
Thro' their veins, with icy darts,
And each hurried oar-stroke keepeth
Time with their o'er-laboring hearts!

XV.

Heavy seems their boat returning,
Weighed with a world of care!
Oh, ye blind ones—none discerning
What the spectral freight ye bear.
Glad they hear the sea-beach grating
Harsh beneath the small boat's stem—
Forth they leap, for no man waiting—
But *the Black Death lands with them.*

XVI.

Viewless—soundless—stalks the spectre
Thro' the city chill and pale,
Which like bride, this morn, had decked her
For the advent of that sail.
Oft by Bergen women, mourning,
Shall the dismal tale be told,
Of that lost ship home returning,
With "THE BLACK DEATH" in her hold!

I would gladly dwell on the pleasures of my second visit to Christiansund, which has a charm of its own, independent of its interest as the spot from whence we really "start for home." But though strange lands, and unknown or indifferent people, are legitimate subjects for travellers' tales, our *friends* and their pleasant homes are *not;* so I shall keep all I have to say of gratitude to our excellent and hospitable Consul, Mr. Mörch, and of admiration for his charming wife, until I can tell you *vivâ voce* how much I wished that you also knew them.

And now though fairly off from Norway, and on our homeward way, it was a tedious business—what with fogs, calms, and headwinds—working towards Copenhagen. We rounded the Scaw in a thick mist, saw the remains of four ships that had run aground upon it, and were nearly run into ourselves by a clumsy merchantman, whom we had the relief of being able to abuse in our native vernacular, and the most racy sea-slang.

Those five last days were certainly the only tedious periods of the whole cruise. I suppose there is something magnetic in the soil of one's own country, which may account for that impatient desire to see it again, which always grows, as the distance from it diminishes; if so, London clay,—and its superstratum of foul, greasy, gas-discolored mud—began about this time to exercise a tender influence upon me, which has been increasing every hour since; it is just possible that the thoughts of seeing you again may have some share in the matter.

Somebody (I think Fuller) says somewhere, that "every one with whom you converse, and every place wherein you tarry awhile, giveth somewhat to you, and taketh somewhat away, either for evil or for good;" a startling consideration for circumnavigators, and such like restless spirits; but a comfortable thought, in some respects, for voyagers to Polar regions, as (except seals and bears) few things could suffer evil from us there; though for our own parts, there were solemn and wholesome influences enough "to be taken away" from those icy solitudes, if one were but ready and willing to "stow" them.

To-morrow I leave Copenhagen, and my good Sigurdr, whose companionship has been a constant source of enjoyment, both to Fitz and myself, during the whole voyage; I trust that I leave with him a friendly remembrance of our too short connexion, and pleasant thoughts of the strange places and things we have seen together; as I take away with me a most affectionate memory of his frank and kindly nature, his ready sympathy, and his imperturbable good humor. From the day on which I shipped him—an entire stranger—until this eve of our separation—as friends, through scenes of occasional discomfort, and circumstances which might sometimes have tried both temper and spirits—shut up as we were for four months in the necessarily close communion of life on board a vessel of eighty tons,—there has never been the shadow of a cloud between us; henceforth, the words "an Icelander" can convey no cold or ungenial associations to my ears, and however much my imagination has hitherto delighted in the past history of that singular island, its Present will always claim a deeper and warmer interest from me, for Sigurdr's sake.

To-morrow Fitz and I start for Hamburg, and very soon after—at least as soon as railroad and steamer can bring me—I look for the joy of seeing your face again.

By the time this reaches Portsmouth, the "*Foam*" will have performed a voyage of six thousand miles.

I have had a most happy time of it, but I fear my amusement will have cost you many a weary hour of anxiety and suspense.

TO THE

FIGURE-HEAD OF "THE FOAM."

I.

CALM sculptured image of as sweet a face
  As ever lighted up an English home,—
Whose mute companionship has deigned to grace
  Our wanderings o'er a thousand leagues of foam,—

II.

Our progress was your triumph duly hailed
  By ocean's inmates; herald dolphins played
Before our stem, tall ships that sunward sailed
  With stately curtseys due obeisance paid.

III.

Fair Fortune's fairer harbinger! you smoothed
  Our way before us, through the frantic fling
Of roystering waves—as once Athene soothed
  The deeps that raged around the wandering King;

IV.

The scowling tempest rose in vain to clutch
His forked bolts; you smiled,—they harmless turned
To sheets of splendor at his palsied touch,
And all their anger perished ere it burned.

V.

Now tinkling waves a peal of welcome rang
Against the sheathing of our brazen bows,—
No gladder hymn the rosy Nereids sang,
When, clad in sunshine, Aphrodite rose.

VI.

Anon, a mightier passion stirred the deep—
Presumptuous billows scaled the quivering deck;
Up to your very lips would dare to leap,
And fling their silver arms about your neck;

VII.

The uncouth winds stole kisses from your cheek,
Then, wild with exultation, hurried on,
And boasting bade their laggard comrades seek
The momentary bliss themselves had won,

VIII.

Who, following, filled our prosperous sails until
We reached eternal winter's drear domain,
Where suns of June but frozen light distil,
And, baffled, quickly abdicate their reign.

IX.

Yet even here your gracious beauty shed
Deep calm; old Ocean slumbered 'neath its spell;
And Summer seemed to follow where you led,
As loth to bid your kindred smile farewell.

X.

The ominous shapes of drifting ice, that pack
The desolate channels of the polar flood,
Clustered like wolves around our Northward track,
Till swayed by that sweet power to altered mood,

XI.

They cowered, and ranged themselves on either side,
  Like vassal ranks who watch some passing Queen
Through her white columned halls in silence glide,
  Nor mingling meet till she no more is seen.

THE END.

SCIENCE IN SHORT CHAPTERS.

BY

W. MATTIEU WILLIAMS, F.R.A.S., F.C.S.

PREFACE.

I AM not aware that this reprint of some of my scattered notes and essays demands any apology.

The practice of making such collections and selections by the author himself has now become very general, and is much better done thus than by friends after his death.

Besides this, it supplies a growing want of these busy times, when so many of us are prevented by the struggles of business from sitting down to the consecutive systematic study of a formal treatise.

I have kept this demand steadily in view throughout, by selecting subjects which are likely to be interesting to all readers who are sufficiently intelligent to prefer sober fact to sensational fiction, but who, at the same time, do not profess to be scientific specialists.

In the writing of these papers my highest literary ambition has always been to combine clearness and simplicity with some attempt at philosophy.

W. M. W.

WILLESDEN, *September*, 1882.

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SCIENCE IN SHORT CHAPTERS.

THE FUEL OF THE SUN.

I offer the following sketch of the main argument which is worked out more fully in the essay I published in January, 1870, under the above title, hoping that many who hesitate to plunge into a presumptuous speculative work of more than 200 octavo pages may read this article, and reflect upon the subject.

The book has been handled in a most courteous and indulgent spirit by all the reviewers who have noticed it, but none have ventured to grapple with the argument it contains, although every possible opportunity and provocation for doing so is designedly afforded. It all rests upon the question which is discussed in the first three chapters, viz., whether the atmosphere which surrounds our earth is limited or unlimited in extent? If my reasoning upon this fundamental question is refuted, all that follows necessarily falls to the ground. If I am right, all our standard treatises on pneumatics and meteorology, which repeat the arguments contained in Dr. Wollaston's celebrated paper, must be remodeled. At the outset, I reprint that paper, and point out a very curious and monstrous fallacy which, for half a century, remained undetected, and had been continually repeated.

As the main point of issue between myself and Dr. Wollaston is merely a question of very simple arithmetic and geometry, nothing can be easier than to set me right if I am wrong; and, as the philosophical consequences depending upon this issue are of vast and fundamental importance, the question cannot be ignored by those who stand before the world as scientific authorities, without a practical abdication of their philosophical responsibilities. Any man who publishes an astronomical or meteorological treatise without discussing this question, which stands before him at the threshold of his subject, is unfit for the task he has undertaken, and unworthy of public confidence. This may appear a strong conclusion just now, but a few years will be sufficient to graft it firmly into the growth of scientific public opinion.*

"The Fuel of the Sun" is simply an attempt to trace some of the consequences which must of necessity result from the existence of an universal atmosphere, and it differs from other attempts to explain the great solar mystery, by making no demands whatever upon the imagination, *inventing* nothing,—no outside meteors, no new forces or materials. It supposes nothing whatever to exist but the known facts of the laboratory—the familiar materials of the earth and its atmosphere. It is shown that these materials and the forces residing within them must of necessity produce a sun, and manifest eternally all the observed solar phenomena, provided only they are aggregated in the quantities which our own central luminary presents, and are surrounded by attendant planets, such as his. Nothing is assumed or taken for granted beyond the simple fundamental hypothesis that the laws of nature are uniform throughout the universe. The argument thus conducted leads us step by step to a natural and connected explanation of the following important phenomena:—

1. The sources of solar and stellar heat and light.
2. The means by which the present amount of solar heat and light must be maintained so long as the solar system continues in existence.
3. The origin of the general and particular phenomena of the sun-spots.

---

* Up to the present date (1882) nobody, as far as I know, has questioned my figures or defended those of Wollaston. Sir William Grove has written to me, pointing out his own anticipations of my conclusions respecting the universality of atmospheric matter. Sir Charles Lyell, before his death, expressed very strong approval of my conclusions, and many other men of scientific eminence have done the same. To expect any immediate, unreserved adoption of such bold speculations would be unreasonable.

4. The cause of the varying splendor of the photosphere, including such details as the "faculæ," "mottling," "granulations," etc., etc.

5. The forces which upheave the solar prominences.

6. The origin of the corona and zodiacal light.

7. The origin of the meteorites and the asteroids.

8. The meteorological phenomena of the planets.

9. The origin of the rings of Saturn.

10. The origin of the special structure of the nebulæ.

11. The source of terrestrial magnetism, and its connection with solar activity.

The first and second chapters are devoted to an examination of the limits of atmospheric expansibility. The experimental investigations of Dr. Andrews, Mr. Grove, Mr. Gassiot, and M. Geissler are cited to prove that the expansibility of the atmosphere is unlimited, and other cosmical evidence is adduced in support of this conclusion.

As this, which is really the foundation of the whole argument, is directly opposed to the views expressed by Dr. Wollaston, in his celebrated paper on "The Finite Extent of the Atmosphere," published in 1822, and generally accepted as established science, this paper is reprinted in the second chapter, and carefully examined.

Dr. Wollaston says "that air has been rarefied so as to sustain 1-100th of an inch of barometrical pressure," and further, that "beyond this limit we are left to conjectures founded on the supposed divisibility of matter; if this be infinite, so also must be the extent of our atmosphere."

I contend that our knowledge of the whole subject is fundamentally altered since these words were written. We are no longer "left to conjectures founded on the supposed divisibility of matter" to determine the possibility of further expansibility than that indicated by 1-100th of an inch of barometrical pressure, as we now have means of obtaining ten times, a hundred times, a thousand times, or even an infinitely greater rarefaction than Wollaston's supposed limit, an apparently absolute vacuum being now obtainable; and although the transmission of electricity affords a means of testing the existence of atmospheric matter with a degree of delicacy of which Wollaston had no conception, we are still unable to detect any indication of any limit to its expansibility.

The most remarkable part of Dr. Wollaston's paper is the *reductio ad absurdum* by which he seeks to finally demonstrate the finite extent of our atmosphere. He maintains, as I do, that if the elasticity of our atmosphere is unlimited, its extension must be commensurate with the universe, that every orb in space will, by gravitation, gather around itself an atmosphere proportionate to its gravitating power, and that, by taking the known quantity of the earth's atmosphere as our unit, we may calculate the amount of atmosphere possessed by any heavenly body of which the mass is known. On this basis Dr. Wollaston calculates the atmosphere of the sun, and concludes that its extent will be so great as to visibly affect the apparent motions of Mercury and Venus, when their declination makes its nearest approach to that of the sun. No such disturbance being actually observable, he concludes that such an atmosphere as he has calculated cannot exist. In like manner he calculates the atmosphere of Jupiter, and finds it to be so great, that its refraction would be sufficient "to render the fourth satellite visible to us when behind the centre of the planet, and consequently to make it appear on both (or all) sides at the same time."

On examining these calculations, I have discovered the very curious error above referred to. As this is a matter of figures that cannot be abridged, I must refer the reader to the original calculations. I will here merely state that Wollaston's method of calculating the solar gravitation atmosphere and that of Jupiter and the moon leads to the monstrous conclusion that, in ascending from the surface of the given orb, we always have the same limited amount of atmospheric matter above as that with which we started, although we are continually leaving a portion of it below.

Wollaston's mistake is based on the assumption that, under the circumstances supposed, the atmospheric pressure and density, at any given distance from the centre of the given orb, will vary inversely with the square of that distance. As the area of the base upon which such pressure is exerted varies *directly* with the square of the distance, the total atmosphere above every imaginable starting-distance would thus be ever the same. That this assumption, so utterly at variance with the known laws of atmospheric distribution, should have remained unchallenged for half a century, and that the conclusions based upon it should be accepted by the whole scientific world, and repeated in standard treatises, such as those of the "Encyclopedia Britannica," etc., etc., is, I think, one of the most remarkable curiosities presented by the history of science. If it were merely a little cobweb in some obscure corner of philosophy, there would be nothing surprising in its escape from the besom of scientific criticism; but this is so far from being the case, that it has hung, since 1822, like a dark veil obscuring another, a wider, and more interesting view of the universe which the idea of an universal atmosphere opens out. But I must now proceed to the next stage of the argument.

Starting from the conclusion reached in the previous chapters, that the atmosphere of our earth is but a portion of an universal elastic medium which it has attached to itself by its gravitation, and that all the other orbs of space must, in like manner, have obtained their proportion, I take the earth's mass, and its known quantity of atmospheric envelope as units, and calculating by the simple rule I have laid down in opposition to Wollaston's, I find that the total weight of the sun's atmosphere should be at least 117,681,623 times that of the earth's, and the pressure at its base equal, at least, to 15,233 atmospheres. What must be the results of such an atmospheric accumulation?

The experiment of compressing air in the condensing syringe, and thereby lighting a piece of German tinder, is familiar to all who have studied even the rudiments of physical science. Taking the formulæ of Leslie and Dalton, and applying them to the solar pressure of 15,233 atmospheres, we arrive according to Leslie, at the inconceivable temperature of 380,832° C., or 685,529° F., as that due to this amount of compression, or, according to Dalton, at 761,665° F. What will be the effects of such a degree of heat upon materials similar to those of which our earth is composed?

Let us first take the case of water, which, for reasons I have stated, should be regarded as atmospheric, or universally diffused matter.

This brings us to a subject of the highest and widest philosophical and practical importance. I refer to the antagonism between the force of heat and that of chemical combination, to which the French chemists have given the name "dissociation." Having myself been unable to find any satisfactory English account of this subject at a time when it had already been well treated by French and German authors, in the form of published lectures and cyclopædia articles, I assume that others may have encountered a similar difficulty, and therefore dwell rather more fully upon this part of my present summary.

It appears that all chemical compounds may be decomposed by heat, and that, at a given pressure, there is a definite and special temperature at which the decomposition of each compound is effected. For the absolute and final establishment of the universality of this law further investigations are necessary, actual investigations having established it as far as they have gone, but these have not been exhaustive.

There appears to be a remarkable analogy between dissociation and evaporation. When a liquid is vaporized, a certain amount of heat is "rendered latent," and this quantity varies with the liquid and with the pressure, but is definite and invariable for each liquid at a given pressure. In like manner, when a compound is dissociated, a certain amount of heat is "rendered latent," or converted into dissociating force, and this varies with each compound and with the pressure, but is definite and invariable for each compound at a given pressure. Further, when condensation occurs, an amount of heat is evolved, as temperature, exactly equal to that which was rendered latent in the evaporation of the same substance under the same pressure; and, in like manner, when chemical re-combination of dissociated elements occurs, an amount of heat is evolved, as temperature, exactly equal to that which disappeared when the compound was dissociated by heat *alone* under the same pressure.

According to the recently adopted figures of M. Deville, the temperature at which the vapor of water becomes dissociated under ordinary atmospheric pressure is 2800° C., and the quantity of heat which disappears, as temperature, in the course of dissociation is 2153 *calorics, i.e.*, sufficient to raise 2153 times its own weight of *liquid* water 1° C.; but, as the specific heat of aqueous vapor is to that of liquid water as 0·475 to 1, that latent heat expressed in the temperature it would have given to aqueous vapor is = 4532° C., or 8158° F.

In order to render the analogy between the ebullition and dissociation of water more evident and intelligible, I will state it as follows:—

To commence the ebullition of water under ordinary pressure, a temperature of 100° C., or 212° F., must be attained.	To commence the dissociation of aqueous vapor under ordinary pressures, a temperature of 2800° C., or 5072° F., must be attained.
To complete the ebullition of a given quantity of water, an amount of heat must be applied, sufficient to have raised the water 537° C., or 968° F., above its boiling-point, had it not evaporated.	To complete the dissociation of a given quantity of aqueous vapor, an amount of heat must be applied sufficient to have raised the vapor 4532° C., or 8158° F., above its dissociation-point had it not decomposed.
In order that a given quantity of vapor of water shall condense, it must give off sufficient heat to raise its own weight of water 537° C., or 968° F.	In order that a given quantity of the elements of water may combine, they must give off sufficient heat to raise their own weight of aqueous vapor 4532° C., or 8158° F.

I have expressed these generalizations and analogies rather more definitely than they have been hitherto stated, but those who are acquainted with the researches of Deville, Cailletet, Bunsen, etc., will perceive that I am justified in doing so.*

---

* Since the above was written these analogies have been generally accepted.

With the general laws of the dissociation of water thus before us, we may follow out the necessary action of the above-stated pressure and consequent evolution of heat in the lower regions of the solar atmosphere upon the large proportion of aqueous vapor which I have shown that it should contain.

It is evident that the first result will be separation of this water into its elements, accompanied with a loss of temperature corresponding to the latent heat of dissociation. We may assume that in the lower regions of the solar atmosphere the free heat evolved by mechanical compression will be more than sufficient to dissociate the whole of the aqueous vapor, and thus the dissociated gases will be left at a higher temperature than was necessary to effect their dissociation. Their condition will thus be analogous to that of superheated steam: they will have to give off some heat before they can *begin* to combine.*

There will, however, be somewhere an elevation at which the heat evolved by the joint compression of the elementary and combined gases will be just sufficient to dissociate the latter, and here will be the meeting surface of the combined and the uncombined constituents of water. There will be a sphere containing combined oxygen and hydrogen surrounded by an atmospheric envelope containing large quantities of aqueous vapor, and the temperature at this limiting surface will be equal to that of the oxyhydrogen flame under a corresponding pressure.

What will occur under these conditions? Will the "detonating gases" behave as in the laboratory? Obviously not, as a glance at the third of the above parallel propositions will show. The dissociated gases cannot combine without giving off their 4532° of latent heat as actual temperature. This can only be effected by communication with matter which is cooler than itself.

---

*Since the publication of "The Fuel of the Sun," Mr. Norman Lockyer has adopted this view of solar dissociation, and has gone so far as to suppose that it splits metals and other substances regarded by modern chemists as simple elements into more elementary and simple constituents. He assumes that the temperature of the solar atmosphere, growing higher at increasing depths, becomes somewhere capable of doing far greater dissociation work than that which separates the hydrogen of the prominences revealed by the spectroscope. In putting forth this "working hypothesis" he seems to have lost sight of the fact clearly proved by Deville's experiments, that the temperature of dissociation rises with the pressure to which the compound is subjected, and thus that within the bowels of the sun the metals will be far less dissociable than they are on the surface of our earth.

If a bubble of steam is surrounded by water maintained at the boiling temperature, it will not condense at all, because any effort of condensation would be accompanied with an evolution of heat exactly sufficient to evaporate its own result. If, however, the surrounding water is slowly radiating, or otherwise losing its heat, the enclosed bubble of steam will condense proportionately, by giving off to its envelope an amount of its latent heat just sufficient to maintain the water at the boiling-point.

For further illustration, let us conceive the case of a certain quantity of the elements of water heated exactly to the temperature of dissociation, and confined in a vessel the sides of which are maintained externally at precisely the same temperature as the gases within, so that no heat can be added or taken away from them. No sensible amount of combination can take place, as the first infinitesimal effort of combustion, or combination, would set free just the amount of heat required to decompose its own result. Let us now suppose a modification of these conditions, viz., that the vessel containing the dissociated gases, at the temperature of dissociation, shall be surrounded with bodies cooler than itself, *i.e.*, capable of receiving more heat from it than they radiate towards it; there would then take place just so much combustion as would set free the amount of heat required to maintain the temperature of the vessel at the dissociation-point; or, in other words, combustion would go on to the extent of setting free just so much heat as the gaseous mass was capable of radiating, or otherwise transmitting to surrounding bodies; and this amount of combustion would continue till all the gases had combined.

We have only to give this hypothetical vessel a spherical form and an internal diameter of 853,380 miles—to construct its enveloping sides of a thick shell of aqueous vapor, etc., and then, by placing in the midst of the contained dissociated gases a nucleus of some kind, we are hypothetically supplied with the main conditions which I suppose to exist in the sun.

A little reflection upon the application of the above-stated laws to these conditions will show that the stupendous ocean of explosive gases would constitute an enormous stock of fuel capable, by its combustion, of setting free exactly the same quantity of heat as had previously been converted into decomposing or separating force; the amount of combustion would always be limited by the possible amount of radiation, and the radiation would again be limited by the resisting envelope of aqueous vapor produced by this combustion.

If these conditions existed in a perfectly calm and undisturbed solar atmosphere, there would be a continally increasing external envelope of aqueous vapor, and a continually diminishing inner atmosphere of combustible gases; there would be a gradual diminution of the amount of solar radiation, and a slow and perpetually retarding progress towards solar extincton.

It should be noted that, according to this explanation, the *supply* of heat is originally derived from atmospheric condensation due to gravitation, that the *storage* of surplus heat is effected by dissociation, and its *evolution* mainly by recombination or combustion.

The great difficulty, that of the perpetual renewal of the solar fuel, still remains unsolved; the fact that during the millions of years of geological history we find no indications of any declining average of solar energy is so far still unexplained by this, as by every other, attempt to account for the origin of solar and stellar light and heat.

In his inaugural address to the British Association Meeting of 1866, Mr. Grove put the following very suggestive question:—"Our sun, our earth, and planets are constantly radiating heat into space; so, in all probability, are the other suns, the stars, and their attendant planets. What becomes of the heat thus radiated into space? If the universe has no limit—and it is difficult to conceive one—there is a constant evolution of heat and light; and yet more is given off than is received by each cosmical body, for otherwise night would be as light and as warm as day. What becomes of the enormous force thus apparently non-recurrent in the same form?

This is a grand question, a philosophical thought worthy of the author of "The Correlation of Physical Forces." Most philosophical thinkers will, I believe, agree with me in concluding that a sound reply to it will solve the great mystery of the everlasting radiations of our sun and all the other suns of the universe. So long as we regard these suns as the *sources* of continually expended forces of light and heat, their everlasting and unabated renewal becomes a mystery utterly inscrutable to the human intellect, since the creation of new force, or any addition to the total forces of the universe, is as inconceivable to us as any addition to the total matter of the universe. The great solar question assumes a far more hopeful shape when we admit that all the forces of past radiations are somewhere diffused in space, and we ask whether a sun contains any mechanism by which it may collect and concentrate this diffused force, and thus perpetually gather from surrounding suns as much as it radiates towards them.

The next part of my work is an attempt to show that such a mechanism does exist in our solar system, and to explain its action.

We know that if atmospheric air is compressed it becomes heated, that if this heat is allowed to radiate and the air is again expanded to its original dimensions, it will be cooled below its original temperature to an extent precisely equal to the heat which it gave out when compressed. On this principle I endeavor to explain the everlasting maintenance of the solar and stellar radiations.

The sun is attended by his train of planets whose orbital motion he controls, but they in return react upon him as the moon does upon the earth. If this reaction were regular, like that of the moon upon the earth, a regular atmospheric tide would result; but the great irregularity of the dimensions, distances, and velocities of the planets produces a result equivalent to a number of clashing irregular tides in the solar atmosphere; or, otherwise stated, the centre of motion and centre of gravity of the whole system will be perpetually varying with the varying relative positions of the planets, and thus the solar nucleus and solar atmosphere will be subject to irregularities of motion, which, though very small relatively to the enormous magnitude of the sun, must be sufficient to produce mighty vortices, and thus effect a continual commingling between the outer and inner atmospheric strata.

It must be remembered that, according to the preceding, the inner or lower strata of the solar atmosphere should consist of our ordinary atmospheric mixture of oxygen and nitrogen, and the dissociated elements of water and carbonic acid, besides some of the more volatile elements of the solar nucleus. Outside of this there should be a boundary limit where the dissociated gases are combining as rapidly as their latent heat can be evolved by radiation; this will form a shell or sphere of flame,—the photosphere,—and above or beyond this will be the sphere of vapors resulting from this combustion, which, by their resistance to radiation, will limit the evolution of heat and consequent combustion.

Now the vortices above referred to will break through the shell of combustion, and drag down more or less of the outer vapor into the lower and hotter regions of dissociated gases.

As there can be no action without equal and contrary reaction, there can be no vortices, either in the solar atmosphere or a terrestrial stream, without corresponding upheavals. These upheavals will eject the lower dissociated gases more or less completely through the vaporous jacket which restrains their normal radiations, and, thus liberated, they will rush into combination with an explosive energy comparable to that which they display in our laboratories; not, however, with an instantaneous flash, but with a continuous rocket-like combustion, the rapidity of which will be determined by the possibility of radiation. The heat evolved by this combustion, acting simultaneously with the diminution of pressure, will effect a continually augmenting expansion of these upheaved gases, and as the rapidity of combustion will be accelerated in proportion to elevation above the restraining vapors, an outspreading far in excess of that which would be due to the original upheaving force, is to be expected.

The reader who is acquainted with the phenomena of the solar prominences will at once perceive how all these expectations are fulfilled by actual observations, especially by the more recent observations of Zollner, Secchi, etc., which exhibit the typical solar prominence as a stem or jet rushing upwards through some restraining medium, and then expanding into a cloud-like or palm-tree form after escaping from this restraint. I need scarcely add that the clashing tide waves are the *faculæ,* and the vortices the sun-spots.

My present business, however, is to show how these vortices and eruptions—this down-rush in one part of the solar atmosphere and up-rush in another—contribute to the permanent maintenance of the solar light and heat. It must be understood that these outbursts are only visible to us as luminous prominences during the period of their explosive outburst, and while still subject to great expansive tension. Long after they have ceased to be visible to us their expansion must continue, until they finally and fully mingle with the medium into which they are flung, and attain a corresponding degree of rarefaction. This must occur at tens and hundreds of thousands of miles above the photosphere, according to the magnitude of the ejection. The spectroscopic researches of Frankland and Lockyer having shown that the atmospheric pressure at about the outer surface of the photosphere does not far exceed that of our atmosphere, I may safely regard all the upper portion of these solar ejections as having left the solar atmosphere proper, and become commingled with the general interstellar medium.

If the sun were stationary, or merely rotating, in the midst of this universal atmosphere, the same material that is ejected to-day would in the course of time return, and be whirled into the great sun-spot eddies; but such is not the case; the sun is driving through the ether with a velocity of about 450,000 miles per twenty four hours.

What must be the consequence of this motion? The sun will carry its own special atmospheric matter with it; but it cannot thus carry the whole of the interstellar medium.

There must be a limit, graduated no doubt, but still a practical limit, at which its own atmosphere will leave behind, or pass through, the general atmospheric matter. There must be a heaping or condensation of this matter in the front, a rarefaction or wake in the rear, and a continuous bow of newly encountered atmosphere around the boundaries in the opposite direction to that of the sun's motion. The result of this must be that a great portion of the ejected atmospheric matter of the prominences will be swept permanently to the rear, and its place supplied by the material occupying the space into which the sun is advancing. We are thus presented with a mighty machinery of solar respiration; some of this newly arriving atmospheric matter must be stirred into the vortices, its quantity being exactly equivalent to that of the old material expired by the explosive eruptions, and left in the rear.

Now, the new atmospheric matter which is thus encountered and inspired, is the recipient of the everlasting radiations whose destination is the subject of Mr. Grove's inquiry; and these, when thus encountered and compressed, will of necessity evolve more or less of the heat which, through millions of millions of centuries they have been gradually absorbing; while, on the other hand, the expired or ejected matter of the gaseous eruptions will, like the artificially compressed air above referred to, have lost all the heat which during its solar existence it had by compression, dissociation, and re-combination contributed to the solar radiations. Therefore, when again fully expanded, it will be cooler than the general medium from which it was originally inspired by the advancing sun.

The daily supply of fresh atmospheric fuel will be a cylinder of ether of the same diameter as the sun, and 450,000 miles in length! I have calculated the weight of this cylinder of ether on the assumption (which of course is purely arbitrary) that the density of the interstellar medium is one ten-thousandth part of that of our atmosphere. It amounts to 14,313,915,000,000,000,000 tons, affording a supply of 165 millions of millions of tons per second; or, if we assume the interstellar medium to have a density of only one-millionth of that of our atmosphere, the supply would be rather more than one and a half millions of millions of tons per second. The proportion of this which is effective in the manner above stated is that which becomes stirred into the lower regions of the sun in exchange for the ejected matter of the prominences.

I will not here dwell upon the bombardment hypothesis, beyond observing that my explanation of solar phenomena supplies a continuous bombardment of the above-stated magnitude without adding anything to the magnitude of the sun.

So far, then, I answer Mr. Grove's question, by showing that the heat radiated into space by each of the solid orbs that people its profundities, is received by the universal atmospheric medium; is gathered again by the breathing of wandering suns, who inspire as they advance the breath of universal heat and light and life; then by impact, compression, and radiation, they concentrate and re-distribute its vitalizing power; and after its work is done, expire it in the broad wake of their retreat, leaving a track of cool exhausted ether—the ash-pits of the solar furnaces—to reabsorb the general radiations, and thus maintain the eternal round of life.

But ere this, a great difficulty has probably presented itself to the mind of the reader. He will refer to the calculations that have been made in order to determine the actual temperature of the solar surface and the intensity of its luminosity. Both of these are vastly in excess of those obtained in our laboratory experiments by the combustion of the elements of water. Even taking into consideration the dissociated carbonic acid whose elements should be burning in the photosphere with those of water, and adding to these the volatile metals of the solar nucleus whose dissociated vapors must, under the circumstances stated, be comming ed with those of the solar atmosphere, and therefore contribute to the luminosity by their combustion, still by burning here on the earth a jet of such mixed gases and vapors we should not obtain any approach to either the luminosity or the temperature which is usually attributed to the sun.

I have made a very few simple experiments, the results of which remove these difficulties. They were conducted with the assistance of Mr. Jonathan Wilkinson, the official gas examiner to the Sheffield Corporation, using his photometric and gas-measuring apparatus. We first determined the amount of light radiated by a single fish-tail gas-burner consuming a measured quantity of gas per hour. We found when another was placed behind this, so that all the light of the second had to pass through the first, that the light of the two (measured by the illuminating intensity of their radiations upon a screen just as the solar luminosity has been measured) was just double that of one flame, three flames (still presenting to the photometric screen only the surface of one) gave it three times the amount of illumination, and so on with any number of flames we were able to test. Mr. Wilkinson has since arranged 100 flames on the same principle, *i. e.*, so that the 99 hinder flames shall all radiate through the one presented to the screen, thus affording the same surface as a single flame, but having 100 times its *thickness* or *depth*, and he finds that the law indicated by our first experiments is fully verified; that the 100 flames thus arranged illuminate the screen 100 times as intensely as the single flame. Other modifications of these experiments, described in Chapter vii. of "The Fuel of the Sun," establish the principle that a common hydrocarbon gas flame is transparent to its own radiations, or, in other words, that the amount of light radiated from such a flame, and its apparent intensity of luminosity, is proportionate to its thickness; therefore the luminosity of the sun may be produced by a photosphere having no greater intrinsic brilliancy than the flame of a tallow candle, provided the flame is of sufficient depth or thickness. I see good reasons for inferring that its intrinsic brilliancy is less than that of a candle—somewhere between that and a Bunsen's burner.

A similar series of experiments upon the radiation of the *heat* of flames through each other, indicated similar results; but my apparatus for these experiments was not so delicate and reliable as in the experiments on light, and, therefore, I cannot so decidedly affirm the absolute diathermancy of flame to its own radiations. Within the limits of error of these experiments, I found that with the same radiant surface presented to the thermometer, every addition to the thickness of the flame produced a proportionate increase of radiation.

This important law, though hitherto unnoticed by philosophers, is practically understood and acted upon by workmen who are engaged in furnace operations. Present space will not permit me to illustrate this by examples, but in passing I may mention the "mill furnaces," where armor-plates and other large masses of iron are raised to a welding temperature by radiant heat, and the ordinary puddling furnace, where iron is melted by radiant heat. In both of these special arrangements are made to obtain a "body" or thickness of radiant flame, while *intensity* of combustion is neglected and even carefully avoided.

According to this there are two factors engaged in producing the radiant effect from a given surface, *intensity* and *quantity*, *i. e.*, *brilliancy* and *thickness* in the case of light, and *temperature* and *thickness* in the case of heat. In the Bude light, for example, consisting of concentric rings of coal-gas, we have small intensity with great quantity, in the lime-light we have a mere surface of great brilliancy but no thickness. If I am right, the surface of the moon may be brighter than the luminous surface of the sun, the peculiarities of moonlight depending upon intensity, those of sunlight upon quantity of light.

The flame that roars from the mouth of a Bessemer converter has but small intrinsic brilliancy, far less than that of an ordinary gas flame, as may be seen by observing the thin waifs that sometimes project beyond the body of the flame. Nevertheless, its radiations are so effective that it is a painfully dazzling object even in the midst of sunny daylight; but then we have here not a hollow flame fed only by outside oxygen, but a solid body of flame several feet in thickness. Even the pallid carbonic acid flame which accompanies the pouring of the spiegeleisen has marvellous illuminating power.

The reader will now be able to understand my explanation of the sun-spots, of their nucleus, umbra, and penumbra. From what I have stated respecting the planetary disturbances or the solar rotation, the photosphere should present all the appearances due to the movements of a fiery ocean, raging and seething in the maddest conceivable fury of perpetual tempest. If the surface of a river flowing peacefully between its banks is perforated with conical eddies whenever it meets with a projecting rock or obstacle, or other agency which disturbs the regularity of its course, what must be the magnitude of the eddies in this ocean of flame and heated gases, when stirred to the lowest depths of its vast profundity by the irregular reeling of the solar nucleus within? Obviously, nothing less than the sunspots; those mighty maelströms into which a world might be dropped like a pea into an egg-cup.

When the photosphere or shell of combining gases is thus ripped open, the telescopic observer looks down the vortex, which, if deep enough, reveals to him the inner regions of dissociated gases and vapors. But these have the opposite property to that which I have shown to belong to flame; they are opaque to their own special radiations, while the flame is transparent to the light of the inner portions of itself. Thus, the dissociated interior of the solar envelope, though absolutely white-hot, will be comparatively dark (direct experiment has proved that the darkness of the spots is only relative).

The sides of the vortex funnel will consist of a mixture of dissociated gases, flaming gases, and combined gases, and will thus present various thicknesses of flame, and thereby display the various shades of the penumbra. Space will not permit me here to follow up the details of this subject, as I have done in the original work, where it is shown that if the telescope had not yet been invented, all the telescopic details of spot phenomena might have been described *à priori* as necessary consequences of the constitution I have above ascribed to the sun.

Not merely the great spot phenomena, but all the minor irregularities of the photosphere follow with similarly demonstrable necessity. Thus the many interfering solar tides must throw up great waves, literally mountainous in their magnitude, the summits and ridges of which, being raised into higher regions of the absorbing vaporous atmosphere that envelopes the photosphere, will radiate more freely, its dissociated matter will combine more abundantly, and will thicken the photosphere immediately below; this thicker flame will be more luminous than the normal surface, and thus produce the phenomena of the *faculæ*.

Besides these great ground-swells of the flaming ocean of the photosphere, there must be lesser billows, and ripples upon these, and mountain tongues of flame all over the surface. The crests of these waves, and the summits of these flame-alps, presenting to the terrestrial observer a greater depth of flaming matter, must be brighter than the hollows and valleys between; and their splendor must be further increased by the fact, that such upper ridges and summits are less deeply immersed in the outer ocean of absorbing vapors, which limits the radiation of the light as well as the heat of the photosphere. The effect of looking upon the surface of such a wild fury of troubled flame, with its confused intermingling of gradations of luminosity, must be very puzzling and difficult to describe; and hence the "willow leaves," "rice grains," "mottling," "granules," "things," "flocculi," "bits of white thread," "cumuli of cotton wool," "excessively minute fragments of porcelain," "untidy circular masses," "ridges," "waves." "hill knolls," etc., etc., to which the luminous irregularities have been compared.

At the time I wrote, the means of examination of the edge of the sun by the spectroscope was but newly discovered, and the results then published referred chiefly to the prominences proper. Since that, a new term has been introduced to solar technology, the "sierra," and the observations of the actual appearances of this sierra precisely correspond to my theoretical description of the limiting surface of the photosphere, which was written before I was acquainted with these observed facts. This will be seen by reference to Chapter x., the subject of which is, "The Varying Splendor of Different Portions of the Photosphere." *

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* Still more recently (1882) the magnificent photographs of Jannsen have displayed further evidence of the flame-tongue character of the mottling.

But I must not linger any further upon this part of the subject, but proceed to another, where subsequent discoveries have strongly confirmed my speculations.

The mean specific gravity of the sun is not quite 1½ times that of water. The vapors of nickel, cobalt, copper, iron, chromium, manganese, titanium, zinc, cadmium, aluminium, magnesium, barium, strontium, calcium, and sodium, have been shown by the spectroscope to be floating on the outer regions of the sun. None of these could constitute the body of the sun in a solid or liquid state, and be subjected to the enormous pressure which such a mass must exert upon itself without raising the mean specific gravity vastly above this; nor is there any other kind of matter with which we are acquainted which could exist within so large a mass in a liquid or solid state, and retain so low a density.

I must confess that my faith in the logical acumen of mathematicians has been rudely shaken by the manner in which eminent astronomers have described the umbra or nucleus of the sun-spots as the solid body of the sun seen through his luminous atmosphere, and the solid surface of Jupiter seen through his belts, and have discussed the habitability of Jupiter, Saturn, Uranus, and Neptune always on the assumption of their solidiy, while the specific-gravity of all of these renders this surface solidity a demonstrable physical impossibility.

If the sun (or either of these planets) has a solid or liquid nucleus, it must be a mere kernel in the centre of a huge orb of gaseous matter, and though I have spoken rather definitely of the solar atmosphere in order to avoid complication, I must not, therefore, be understood to suppose that there exists in the sun any such definite boundary to the base of the atmospheric matter as we find here on the earth. The temperature, the density, and all we know of the chemistry of the sun justify the conclusion that in its outer regions, to a considerable depth below the photosphere, there must be a commingling of the atmospheric matter with the vapors of the metals whose existence the spectroscope has revealed. Some of these must be upheaved together with the dissociated elements of water. They are all combustible, and, with a few exceptions, the products of their combustion would solidify after they were projected beyond the photosphere. Much of the iron, nickel, cobalt, and copper might pass through the fiery ordeal of such projection, and solidify without oxidation, especially when more or less enveloped in uncombined hydrogen.

It is obvious that, under these circumstances, there must occur a series of precipitations analogous to those from the aqueous vapor of our atmosphere. These gaseous metals, or their oxides, must be condensed as clouds, rain, snow, and hail, according to their boiling and metal points, and the conditions of their ejection. We know that sudden and violent atmospheric disturbance, accompanied with fierce electrical discharges, especially favor the formation of hailstones in our terrestrial atmosphere. All such violence must be displayed on a hugely exaggerated scale in the solar outbursts, and therefore the hailstone formation should preponderate, especially as the metallic vapors condense more rapidly than those of water on account of the much smaller amount of their specific heat, and of the latent heat of their vapors.

What will become of these volleys of solid matter thus ejected with the furious and protracted explosions forming the solar prominences? In order to answer this question, we must remember that the spectroscope, as recently applied, merely displays the gaseous, chiefly the hydrogen, ejections; that these great gaseous flames bear a similar relation to the solid projectiles that the flash of a gun does to the grape-shot or cannon-ball. Mr. Lockyer says: "In one instance I saw a prominence 27,000 miles high change enormously in the space of ten minutes; and, lately, I have seen prominences much higher born and die in an hour." He has recently measured an actual velocity of 120 miles per second in the movements of this *gaseous* matter of the solar eruptions, the initial velocity of which must have been much greater.* If such is the velocity of the gaseous ejections, what must be that of the solid projectiles, and where must they go?

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* Subsequent observations (1882) by Secchi, Young, and others have demonstrated velocities far exceeding this; quite sufficient to project the solid matter clearly beyond the sphere of solar attraction.

A cosmical cannonade is a necessary result of the conditions I have sketched, and as prominence-ejections are continually in progress, there must be a continual outpouring from the sun of solid fragments, which must be flung far beyond the limits of the gaseous prominences. As the luminosity of these glowing particles must be very small compared with that of the photosphere, they will be invisible in the glare of ordinary sunshine ; but if our eyes be protected from this, they may then be rendered visible, both by their own glow and the solar light they are capable of reflecting. They should be seen during a total eclipse, and should exhibit radiant streams proceeding irregularly from different parts of the sun, but most abundantly from the neighborhood of the spot regions. As these spot regions occupy the intermediate latitudes between the poles and the equator of the sun, the greatest extensions of the outstreamings should be N.E. and S.W., and S.E. and N.W., while to the N., S., E., and W.—that is, opposite the poles and equator of the sun—there should be a lesser extension. The result of this must be an approximation to a quadrilateral figure, the diagonals of which should extend in a N.E. and S.W., and a S.E. and N.W. direction, or thereabouts. I say "thereabouts," because the zone of greatest activity is not exactly intermediate between the poles and the equator, but lies nearer to the solar equator.

Examined with the polariscope, these radiant streams should display a mixture of reflected light and self-luminosity. Examined with the spectroscope, a faint continuous spectrum due to such luminosity of solid particles should be exhibited, with possibly a few lines due to the small amount of vapor which, in their glowing condition, they might still give off. Besides this, there should appear the spectroscope indications of violent electrical discharges, which must occur as a necessary concomitant of the furious ejections of aqueous vapor and solid particles. All these metallic hailstones must be highly charged, like the particles of vesicular vapor ejected from the hydro-electric machine, or the vapors and projectiles of a terrestrial volcanic eruption.

I need scarcely add that this exactly describes the actually-observed results of the recent observations on the corona, and that all the phenomena of this great solar mystery are but necessary and predicable results of the constitution I ascribe to the sun.

There is a method of manufacturing hypotheses which has become rather prevalent of late, especially among mathematicians, who take observed phenomena, and then arbitrarily and purely from the raw material of their own imagination construct explanatory atoms, media, and actions, which are shaved and pared, scraped and patched, lengthened and shortened, thickened and narrowed, till they are made to fit the phenomena with mathematical accuracy. These laborious creations are then put forth as philosophical truths, and, *afterwards,* the accuracy of their fitting to the phenomena is quoted as evidence of the positive reality of the ethers, atoms, undulations, gyrations, collisions, or whatever else the mathematician may have thus skilfully created and fitted. It appears to me that such fitness only proves the ingenuity of the fitter—the skill of the mathematician—and that all such hypotheses belong to the poetry of science; they should be distinctly labelled as products of mathematical imagination, and nowise be confounded with objective natural truths. Such products of the imagination of the expert may assist the imagination of the student in comprehending some phenomena, just as "Jack Frost" and "Billy Wind" may represent certain natural forces to babies; but if Jack Frost, Billy Wind, electric and magnetic fluids, ultimate atoms, interatomic ethers, nervous fluids, etc., are allowed to invade the intellect, and are accepted as actual physical existences, they become very mischievous philosophical superstitions.

I make this digression in order to repudiate any participation in this kind of speculation. Though "The Fuel of the Sun" is avowedly a very bold attempt to unravel majestic mysteries, I have not sought *to elucidate the known by means of the unknown,* as do these inventors of imaginary agents, but have scrupulously followed the opposite principle. I have invented nothing, but have started from the experimental facts of the laboratory, the demonstrated laws of physical action, and have followed up step by step what I understand to be the necessary consequences of these. Many years ago I convinced myself that our atmosphere is but a portion of universal atmospheric matter; that Dr. Wollaston was wrong, and that the compression of this universal atmospheric matter is possibly the source of solar light and heat; but as this was long before M. Deville had investigated the subject of dissociation by heat,* I was unable to work out the problem at all satisfactorily. When I subsequently resumed the subject, I knew nothing about the corona, and had only read of the "red prominences" as possible lunar appendages, or solar clouds, or optical illusions. I had worked out the necessity of the gaseous eruptions, and their action in effecting an interchange of solar and general atmospheric matter, as the means of maintaining the solar light and heat, with no idea of proceeding further with the problem, when the announcement that the prominences were not merely unquestionable solar appendages, but were actually upheaved mountains of glowing hydrogen, suddenly and unexpectedly suggested their identity with my required atmospheric upheavals. It is true that their observed magnitude far exceeded my theoretical anticipations, and in this respect I have made some *à posteriori* adaptations, especially with the aid of a clearer understanding of the laws of dissociation which almost simultaneously became attainable.

In like manner, the necessity of the solid ejections presented themselves before I knew anything of the recently discovered details of the coronal phenomena—when I had merely read of a luminous halo which had been seen around the sun, and relying upon Mr. Lockyer, vaguely supposed it to be an effect of atmospheric illumination. I inferred that streams of solid particles must be pouring from the sun, and showering back again, but had no idea that such streams and showers were actually visible until I was rather startled on learning that the corona, instead of being, as I had loosely supposed, a mere uniform filmy halo, had been described by Mr. De la Rue, in his Bakerian Lecture on the Eclipse of 1860, as "softening off with very irregular outline, and sending off some *long streams*," etc. I was then living on the sides of a Welsh mountain far away from public libraries, and being no astronomer, my own books kept me better acquainted with the current progress of experimental than with astronomical science.

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* My first memorandum on this subject is dated April 23, 1840, in a *Register of Ideas*, then commenced in very early student days.

Even when "The Fuel of the Sun" was published I knew nothing of the American observations of the quadrangular figure of the corona, or should certainly have then quoted them, nor of the fact revealed by the Eclipse of December, 1870, that, "wherever on the solar disc a large group of prominences was seen on Mr. Seabroke's map, there a corresponding bulging out of the corona was chronicled on Professor Watson's drawing; and at the positions where no prominences presented themselves, there the bright portions of the corona extended to the smallest distances from the sun's limb; and that Mr. Brothers's photographs *all* show the corona extending much further towards the west than towards the east, the west being "the region richest in solar prominences." I am sorry that the limits of this paper will not permit me to enter more fully into the bearings of the recent studies of the corona and the prominences upon my explanations of solar phenomena, especially as the differences between the inner and outer corona, which still appear to puzzle astronomers, are exactly what my explanation demands. I must make this the subject of a separate paper, and proceed at once to the next step of the general argument.

Assuming that such ejections of solid matter are poured from the prominences, to what distances may they travel? In attempting to answer this question, I avowedly ventured upon dangerous ground, for at the time of writing I only knew that the force of upheaval of the prominences must be enormous, *probably* sufficient to eject solid matter beyond the orbit of the earth and even beyond that of Mars. Actual measurements of the eruptive velocity of the solar prominences have since been made, and they are so great as to relieve me of my quantitative difficulty, and show that I was quite justified in the bold inference that these eruptions may account for the zodiacal light, the zones of meteors into which our earth is sometimes plunged, and even the outer zone of larger bodies, the asteroids.

But how, the reader will ask, can such solids, ejected from the sun, acquire orbital paths around him "We have been taught that the parabola is the necessary path of such ejections." Mr. Proctor has evidently reasoned in this manner, for in last April number of "Fraser's Magazine" he says that some of my ideas are "opposed to any known laws, physical or dynamical," that "there is nothing absolutely incredible in the conception that masses of gaseous, liquid, or solid matter should be flung to a height exceeding manifold that of the loftiest of the colored prominences; whereas it is not only incredible, but impossible, that such matter should in any case come to circle in a closed orbit round the sun."

More careful reading would have shown Mr. Proctor that I have considered other conditions besides those of the text-books, that the case is by no means one of simple radial projection from a fixed body into free space and undisturbed return. I distinctly stated that "the recent ejections may have any form of orbit within the boundaries of the conic sections," from a straight line returning upon itself, due to absolutely vertical projection, to a circular orbit produced by the tangential projection of such curving prominences *as the ram's horn*, etc. The outline of the zodiacal light would be formed by the termination or aphelion portion of these excursions, or of such a number of them as should be sufficient to produce a visible result.

Again, speaking of the asteroids, in Chapter xiv., I state that "I should have expected a still greater elongation and eccentricity in some of them, and such orbits may have existed; but an asteroid with an orbit of cometary eccentricity that would in the course of each revolution cross the paths of Mercury, Venus, the Earth, and Mars in nearly the same plane, and dive through the thickly scattered zodiacal cluster, both in going to the sun and returning from it, would be subject to disturbances which would continue until one of two things occurred. Its tangential force might become so far neutralized and its orbit so much elongated, that finally its perihelion distance should not exceed the solar radius, when it would finish its course by returning to the sun. On the other hand, its tangential velocity might be increased by heavy pulls from Jupiter, when slowly turning its aphelion path, and be similarly influenced by friendly jerks in crossing the orbits of the inferior planets; and thus its orbit might be widened, until it ceased periodically to cross the path of any of the planets by establishing itself in an orbit constantly intermediate between any two. Having once settled into such a path, it would remain there with comparative stability and permanency. If I am right in this view of the dynamical history of these older ejections, all the long elliptical paths of zodiacal particles, meteorites, or asteroids, would thus in the course of ages become eliminated, and the remaining orbits would be of planetary rather than cometary proportions."

A little reflection on the above-stated laws of dissociation will show that the maximum violence of hydrogen explosion will not occur at the birth of the ejections, but afterwards, when the dissociated gases have been already hurled beyond the sphere of restraining vapors. If my explanation is correct, the typical form of a solar prominence should be that of a spreading tree with a tall stem. At first the least resistence to radiation and consequent explosive combination must be in the vertical direction, as this will afford the shortest line that can be drawn through the thickness of the surrounding jacket of resisting vapor; but when raised above this envelope, the dissociated gases, cooled by their own expansion and comparatively free to radiate in all directions except downwards, will explode laterally as well as vertically, and thus spread out into a head. My theoretical prominence will be, in short, a monster rocket proceeding steadily upwards to a certain extent, and then gradually bursting and projecting its missiles in every direction from the vertical to the absolutely horizontal. Should the latter acquire a velocity of about 300 miles per second, not merely a closed but even an absolutely circular orbit would be possible. These and the multitude of weaker lateral ejections, reaching the sun by short parabolic paths, explain the mystery of the inner corona.

I need only refer Mr. Proctor to his own recently published book on the Sun, where he will find on plates 4, 5, and 6 a number of drawings from Zöllner and Respighi, which so thoroughly confirm my necessary theoretical deductions that they might be a series of fancy sketches of my own. When we consider that the base of a prominence is only visible when it happens to start exactly from the limb of the sun, while the vastly greater proportion of those which are observed, and have been drawn, have much of the stem cut off from view by the solar rotundity, the evidence afforded by such drawings in support of my theoretical deduction, that the typical form of the solar prominences is that of a palm-tree or bursting rocket, is greatly strengthened.*

In a paper by P. Secchi, dated Rome, March 20, 1871, and published in the "Comptes Rendus," March 27, this veteran solar observer speaks of the prominences as composed of jets, which, "upon reaching a certain elevation, stop and whirl upon themselves, giving birth to a brilliant cloud." This cloud is represented as spreading out on all sides from the summit of the combined jets. Again he says, "It is very common to see a litte jet spot at a certain elevation above the chromosphere, and there spread itself out into a *wide hat* ("*un large chapeau*") of an absolutely nebulous constitution." This outspreading nebulosity is the flash of the incandescent vapors produced by the explosion which is theoretically demanded by my explanation to occur exactly in the manner and place described. These expanded incandescent gases will be rendered visible by the spectroscopic dilution of the continuous spectrum of the denser photosphere, while the solid projectiles that must proceed from them in every direction can only be seen during a solar eclipse.

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* Any reader of "The Fuel of the Sun" will perceive that the vaporous envelope which I have described as "an effectual jacket for limiting the amount of radiation," is a complete theoretical anticipation and explanation of the "solar crust" of Respighi and the "Trennungschicht" of Zöllner. We agree perfectly in our conclusions, though arriving at them by such very different paths, and so independently of each other.

The observations and drawings of Zöllner and Respighi were, for the most part, made while my book was in the press, and, like those of Secchi above quoted, were unknown to me when I wrote; I was then only able to quote, in support of my theoretical requirements, the evidences of actually observed tangential ejection afforded by Sir John Herschel's account of the great solar storm of September 1, 1859.

Besides this direct tangential projection there are other elements of motion contributing to the same result, such as the whirl of the prominences on themselves, their motion of translation on the sun's disk, and the rotation of the sun itself.

I must now bring this sketch to a close by stating that, in order to submit the fundamental question of an universal atmosphere to an *experimentum crucis* analogous to that by which Pascal tested the atmospheric theory of Torricelli, I have calculated the theoretical density of the atmosphere of the moon and of each of the planets, and compared the results as severely as I could with the observed facts. As Jupiter is 27,100 times heavier than the moon, and between these wide extremes there are six planets presenting great variations of mass, the probabilities of accidental coincidence are overwhelmingly against me, and a close concurrence of observed telescopic refraction and other phenomena with the theoretical atmospheric density must afford the strongest possible confirmation of the soundness of the basis of my whole argument. Such a concurrence exists, and some new and very curious light is unexpectedly thrown upon the meteorology of Mars and the constitution of the larger planets. The latter, if I am right, must be miniature suns, *permanently* red or white-hot, must be something like a photosphere, surrounded by a sphere of vapor (the outside of which we see), must have mimic spot vortices and prominences, and in the case of Saturn must eject volleys of meteoric matter, some of which should finally settle down into orbital paths, and thus produce the rings.

These are startling conclusions, and when I reached them they were utterly at variance with general astronomical opinion, but I find since their publication that some astronomers have already shown considerable readiness to adopt them. In my case this view of the solar constitution of the larger planets is not a matter of mere opinion, or guessing, or probability, but it follows of necessity, and as stated on page 200, "the great mystery of Saturn's rings is resolved into a simple consequence, a demonstrable and necessary result of the operation of the familiar forces, whose laws of action have been demonstrated here upon the earth by experimental investigation in our laboratories. No strained hypotheses of imaginary forces are required, no ethers or other materials are demanded, beyond those which are beneath our feet and around our heads here upon our own planet; all that is necessary is to grant that the well-known elements and compounds of the chemist, and the demonstrated forces of the experimental physicist, exist and operate in the places, and have the quantities and modes of distribution described by the astronomer; this simple postulate admitted, these wondrous appendages spring into rational existence, and like the eternal fires of the sun, the barren surface of the moon, the dry valleys of Mercury, the hazy equivocations of Venus, the seas and continents and polar glaciers of Mars, and the cloud-covered face Jupiter, follow as necessary consequences of an universal atmosphere."

If I am right in ascribing a gaseous condition to the sun and the larger planets, and tracing the maintenance of this condition to the disturbing gravition of the attendant planets or satellites, a solution of the riddle of the nebulæ at once presents itself. We have only to suppose a star cluster or group composed of orbs of solar or great planetary dimensions, and that these act mutually upon each other as the planets on our sun, or the satellites upon Saturn, but in a far more violent degree owing to the far greater relative masses of the reacting elements, and we obtain the conditions under which great gaseous orbs would be not merely pitted on their surface, but riven to their very centres, moulded and shaped throughout by the whirling hurricane of their whole substance. When thus in the centre of a tornado of opposing gravitations the tortured orb would be twisted bodily into a huge vorticose crater, into the bowels of which the aqueous vapor would be dragged and dissociated, and then, entangled with the inner matter of the riven sphere, would be hurled upwards, again to burst forth in an explosion of such magnitude that the original body would be measurably presented as a mere appendage, the rocket case of the flood of fire it had vomited forth.

The reader must complete the picture. If he will take a little trouble in doing so he will find that it becomes a portrait of one or the other of the nebulæ, according to the kind of intergravitating star-cluster from which he starts. I have endeavored to work out some of the details of the nebular conditions in Chapter xx. In Chapter xxi. I have concluded by showing the analogy between a sun and the hydro-electric machine, the sun being the cylinder and the prominences the steam jets. If issuing jets of high-pressure steam have the same properties at a distance of 93 millions of miles from the earth as upon its surface, the body of the sun and the issuing steam must be in opposite electrical conditions, and furious electrical excitation must result; and if the laws of electrical induction are constant throughout the universe, the earth must be as necessarily subject to solar electrical influence as to his thermal radiations. Thus the same reasoning which explains the origin and maintenance of the solar heat and light, the sun-spots, the photosphere, the chromosphere, the sierra, the prominences, the zodiacal light, the aerolites and asteroids; the meteorology of the planets and the rings of Saturn, also shows how the electrical disturbances which produce the aurora borealis and direct the needle may originate.

Electrical theories of the corona and zodiacal light, and their connection of some kind with the aurora borealis, have been put forth in many shapes, but so far as I have learned none afford any explanation of the *origin* of the electrical disturbance. Without this they are like the vortices of Descartes, which explained the movements of the planets by supposing another kind of motion still more incomprehensible.

Explanations which are more difficult to explain than the phenomena they propose to elucidate only obscure the light of true science, and stand as impedimente to the progress of sound philosophy.

DR. SIEMENS' THEORY OF THE SUN.

A PAPER was read on March 2, 1882, by Dr. C. W. Siemens at the Royal Society, and he published an article on "A New Theory of the Sun" in the April number of the *Nineteenth Century*. All who have read my essay on "The Fuel of the Sun" are surprised at the statement with which the magazine article opens, viz.: that this "may be termed a first attempt to open for the sun a debtor and creditor account, inasmuch as he has hitherto been regarded only as a great almoner pouring forth incessantly his boundless wealth of heat, without receiving any of it back."

Some of my friends suppose that Dr. Siemens has wilfully ignored the most important element of my theory, and have suggested indignation and protest on my part. I am quite satisfied, however, that they are mistaken. I see plainly enough that although Dr. Siemens quotes my book, he had not read it when he did so; that in stating that "Grove, Humboldt, Zoellner, and Mattieu Williams have boldly asserted the existence of a space filled with matter," he derived this information from the paper of Dr. Sterry Hunt which he afterward quotes. This inference has been confirmed by subsequent correspondence with Dr. Siemens, who tells me that he saw the book some years since but *had not read it*. My contributions to the philosophy of solar physics would have been far more widely known and better appreciated had I followed the usual course of announcing firstly "a working hypothesis," to warn others off the ground, then reading a preliminary paper, then another and another, and so on during ten or a dozen years, instead of publishing all at once an octavo volume of 240 pages, which has proved too formidable even to many of those who are specially interested in the subject.

I am compelled to infer that this is the reason why so many of the speculations, which were physical heresies when expounded therein, have since become so generally adopted, without corresponding acknowledgment. This is not the place for specifying the particulars of such adoptions, but I may mention that in due time "An Appendix to the Fuel of the Sun," including the whole history of the subject, will be published. The materials are all in hand, and only await arrangement. In the meantime I will briefly state some of the points of agreement and difference between Dr. Siemens and myself.

In the first place, we both take as our fundamental basis of speculation the idea of an universal extension of atmospheric matter, and we both regard this as the recipient of the diffused solar radiations, which are afterwards recovered and recondensed, or concentrated. Thus our "fuel of the sun" is primarily the same, but, as will presently be seen, our machinery for feeding the solar furnace is essentially different.

Certain desiccated pedants have sneered at my title, "The Fuel of the Sun," as "sensational," and have refused to read the book on this account; but Dr. Sterry Hunt has provided me with ample revenge. He has disentombed an interesting paper by Sir Isaac Newton, dated 1675, in which the same sensationalism is perpetrated with very small modification, Sir Isaac Newton's title being "Solary Fuel." Besides this, his speculations are curiously similar to my own, his fundamental idea being evidently the same, but the chemistry of his time was too vague and obscure to render its development possible. This paper was neglected and set aside, was not printed in the Transactions of the Royal Society, and remained generally unknown till a few months ago, when the energetic American philosopher brought it forth, and discussed its remarkable anticipations.

Dr. Siemens supposes that the rotation of the sun effects a sort of "fan action," by throwing off heated atmospheric matter from his equatorial regions, which atmospheric matter is afterwards reclaimed and passed over to the polar regions of the sun. This interchange he describes as effected by the differences of pressure on the fluid envelope of the sun; the portion over the polar regions being held down by the whole force of solar gravitation, while the equatorial atmosphere is subject to this pressure, or attraction, minus the centrifugal impulse due to solar rotation. He maintains that this "centrifugal action, however small in amount as compared with the enormous attraction of the sun, would destroy the balance, and determine a motion towards the sun as regards the mass opposite the polar surface, and into space as regards the equatorial mass." He adds that "the equatorial current so produced, owing to its mighty proportions, would flow outwards into space, to a practically unlimited distance."

I will not here discuss the dynamics of this hypothesis; whether the reclaiming action of the superior polar attraction would occur at the vast distances from the sun supposed by Dr. Siemens, or much nearer home, and produce an effect like the recurving of the flame of his own regenerative gas-burner; or, whether he is right in comparing the centrifugal force at the solar equator with that of the earth, by simply measuring the relative velocity of translation irrespective of angular velocity. I will merely suggest that in discussing these, it is necessary, in order to do justice to Dr. Siemens, to always keep in mind the assumed condition of an universal and continuous atmospheric medium, and not to reason, as some have done already, upon the basis of a limited solar atmosphere with a definite boundary, from beyond which particles of atmospheric matter are to be flung away into vacuous space, without the intervention of all-pervading fluid pressure.

It is evident that *if* such fan action can bring back *all* the material that has received the solar radiations, and which holds them either as temperature or otherwise, the restoration and perpetuation of solar energy will be complete, for even the heat received by our earth and its brother and sister planets would still remain in the family, as they would radiate it into the interplanetary atmospheric matter supposed to be reclaimed by the sun.

But, as Mr. Proctor has clearly shown, the rays of the sun cannot do all the work thus required for his own restoration without becoming extinguished as regards the outside universe ; and if the other suns—*i.e.*, the stars—do the same they could not be visible to us.

Thus Dr. Siemens' theory removes our sun from his place among the stars, and renders the great problem of stellar radiation more inscrutable than ever by thus putting the evidence of our great luminary altogether out of court.

My theory, on the contrary, demands only a gradual absorption of solar and stellar rays, such as actual observation of their varying splendor indicates.

If space were absolutely transparent, and its infinite depths peopled throughout, the firmament would present to our view one continuous blazing dome, as all the spaces between the nearer stars would be filled by the infinity of radiations from the more distant.

ANOTHER WORLD DOWN HERE.

WHAT a horrible place must this world appear when regarded according to our ideas from an insect's point of view! The air infested with huge flying hungry dragons, whose gaping and snapping mouths are ever intent upon swallowing the innocent creatures for whom, according to the insect, if he were like us, a properly constructed world ought to be exclusively adapted. The solid earth continually shaken by the approaching tread of hideous giants—moving mountains—that crush out precious lives at every footstep, an occasional draught of the blood of these monsters, stolen at life-risk, affording but poor compensation for such fatal persecution.

Let us hope that the little victims are less like ourselves than the doings of ants and bees might lead us to suppose ; that their mental anxieties are not proportionate to the optical vigilance indicated by the four thousand eye-lenses of the common house-fly, the seventeen thousand of the cabbage butterfly and the wide-awake dragon-fly, or the twenty-five thousand possessed by certain species of still more vigilant beetles.

Each of these little eyes has its own cornea, its lens, and a curious six-sided, transparent prism, at the back of which is a special retina spreading out from a branch of the main optic nerve, which, in the cockchafer and some other creatures, is half as large as the brain. If each of these lenses forms a separate picture of each object rather than a single mosaic picture, as some anatomists suppose, what an awful army of cruel giants must the cockchafer behold when he is captured by a schoolboy!

The insect must see a whole world of wonders of which we know little or nothing. True, we have microscopes, with which we can see one thing at a time if carefully laid upon the stage; but what is the finest instrument that Ross can produce compared to that with twenty-five thousand object-glasses, all of them probably achromatic, and each one a living instrument, with its own nerve-branch supplying a separate sensation? To creatures thus endowed with microscopic vision, a cloud of sandy dust must appear like an avalanche of massive rock-fragments, and everything else proportionally monstrous.

One of the many delusions engendered by our human self-conceit and habit of considering the world as only such as we know it from our human point of view, is that of supposing human intelligence to be the only kind of intelligence in existence. The fact is, that what we call the lower animals have special intelligence of their own as far transcending our intelligence as our peculiar reasoning intelligence exceeds theirs. We are as incapable of following the track of a friend by the smell of his footsteps as a dog is of writing a metaphysical treatise.

So with insects. They are probably acquainted with a whole world of physical facts of which we are utterly ignorant. Our auditory apparatus supplies us with a knowledge ef sounds. What are these sounds? They are vibrations of matter which are capable of producing corresponding or sympathetic vibrations of the drums of our ears or the bones of our skull. When we carefully examine the subject, and count the number of vibrations that produce our world of sounds of varying pitch, we find that the human ear can only respond to a limited range of such vibrations. If they exceed three thousand per second, the sound becomes too shrill for average people to hear it, though some exceptional ears can take up pulsations or waves that succeed each other more rapidly than this.

Reasoning from the analogy of stretched strings and membranes, and of air vibrating in tubes, etc., we are justified in concluding that the smaller the drum or the tube the higher will be the note it produces when agitated, and the smaller and the more rapid the aerial wave to which it will respond. The drums of insect ears, and the tubes, etc., connected with them, are so minute that their world of sounds probably begins where ours ceases; that the sound which appears to us as continuous is to them a series of separated blows, just as vibrations of ten to twelve per second appear to us. We begin to hear such vibrations as continuous sounds when they amount to about thirty per second. The insect's continuous sound probably begins beyond three thousand. The blue-bottle may thus enjoy a whole world of exquisite music of which we know nothing.

There is another very suggestive peculiarity in the audtory apparatus of insects. Its structure and position are something between those of an ear and of an eye. Careful examination of the head of one of our domestic companions—the common cockroach or black-beetle—will reveal two round white points, somewhat higher than the base of the long outer antennæ, and a little nearer to the middle line of the head. These white projecting spots are formed by the outer transparent membrane of a bag or ball filled with fluid, which ball or bag rests inside another cavity in the head. It resembles our own eye in having this external transparent tough membrane, which corresponds to the cornea or transparent membrane forming the glass of our eye-window; which, like the cornea, is backed by the fluid in an ear-ball corresponding to our eye-ball, and the back of this ear-ball appears to receive the outspreadings of a nerve, just as the back of our eye is lined with that outspread of the optic nerve forming the retina. There does not appear to be in this or other insects a tightly stretched membrane which, like the membrane of our ear-drum, is fitted to take up bodily air-waves and vibrate responsively to them. But it is evidently adapted to receive and concentrate some kind of vibration, or motion, or tremor.

What kind of motion can this be? What kind of perception does this curious organ supply? To answer these questions we must travel beyond the strict limits of scientific induction and enter the fairyland of scientific imagination. We may wander here in safety, provided we always remember where we are, and keep a true course guided by the compass-needle of demonstrable facts.

I have said that the cornea-like membrane of the insect's ear-bag does not appear capable of responding to *bodily* air-waves. This adjective is important, because there are vibratory movements of matter that are not bodily but molecular. An analogy may help to render this distinction intelligible. I may take a long string of beads and shake it into wavelike movements, the waves being formed by the movements of the whole string. We may now conceive another kind of movement or vibration by supposing one bead to receive a blow pushing it forward, this push to be communicated to the next, then to the third, and so on, producing a minute running tremor passing from end to end. This kind of action may be rendered visible by laying a number of billiard balls or marbles in line and bowling an outside ball against the end one of the row. The impulse will be rapidly and invisibly transmitted all along the line, and the outer ball will respond by starting forward.

Heat, light, and electricity are mysterious internal movements of what we call matter (some say "ether," which is but a name for imaginary matter). These internal movements are as invisible as those of the intermediate billiard balls; but if there be a line of molecules acting thus, and the terminal one strikes an organ of sense fitted to receive its motion, some sort of perception may follow. When such movements of certain frequency and amplitude strike our organs of vision, the sensation of light is produced. When others of greater amplitude and smaller frequency strike the terminal outspread of our common sensory nerves, the sensation of heat results. The difference between the frequency and amplitude of the heat waves and the light waves is but small, or, strictly speaking, there is no actual line of separation lying between them; they run directly into each other. When a piece of metal is gradually heated, it is first "black-hot;" this is while the waves or molecular tremblings are of a certain amplitude and frequency; as the frequency increases and amplitude diminishes (or, to borrow from musical terms, as the pitch rises), the metal becomes dull red-hot; greater rapidity, cherry red; greater still, bright red; then yellow-hot and white-hot: the luminosity growing as the rapidity of molecular vibration increases.

There is no such gradation between the most rapid undulations or tremblings that produce our sensation of sound and the slowest of those which give rise to our sensations of gentlest warmth. There is a huge gap between them, wide enough to include another world or several other worlds of motion, all lying between our world of sounds and our world of heat and light, and there is no good reason whatever for supposing that matter is incapable of such intermediate activity, or that such activity may not give rise to intermediate sensations, provided there are organs for taking up and sensifying (if I may coin a desirable word) these movements.

As already stated, the limit of audible tremors is three to four thousand per second, but the smallest number of tremors that we can perceive as heat is between three and four millions of millions per second. The number of waves producing red light is estimated at four hundred and seventy-four millions of millions per second; and for the production of violet light, six hundred and ninety-nine millions of millions. These are the received conclusions of our best mathematicians, which I repeat on their authority. Allowing, however, a very large margin of possible error, the world of possible sensations lying between those produced by a few thousands of waves and any number of millions is of enormous width.

In such a world of intermediate activities the insect probably lives, with a sense of vision revealing to him more than our microscopes show to us, and with his minute eye-like ear-bag sensifying material movements that lie between our world of sounds and our other far-distant worlds of heat and light.

There is yet another indication of some sort of intermediate sensation possessed by insects. Many of them are not only endowed with the thousands of lenses of their compound eyes, but have in addition several curious organs that have been designated "ocelli" and "stemmata." These are generally placed at the top of the head, the thousand-fold eyes being at the sides. They are very much like the auditory organs above described—so much so that in consulting different authorities for special information on the subject I have fallen into some confusion, from which I can only escape by supposing that the organ which one anatomist describes as the ocelli of certain insects is regarded as the auditory apparatus when examined in another insect by another anatomist. All this indicates a sort of continuity of sensation connecting the sounds of the insect world with the objects of their vision.

But these ocular ears or auditory eyes of the insect are not his only advantage over us. He has another sensory organ to which, with all our boasted intellect, we can claim nothing that is comparable, unless it be our olfactory nerve. The possibility of this I will presently discuss.

I refer to the *antennæ,* which are the most characteristic of insect organs, and wonderfully developed in some, as may be seen by examining the plumes of the crested gnat. Everybody who has carefully watched the doings of insects must have observed the curiously investigative movements of the antennæ, which are ever on the alert, peering and prying to right and left and upwards and downwards. Huber, who devoted his life to the study of bees and ants, concluded that these insects converse with each other by movements of the antennæ, and he has given to the signs thus produced the name of "antennal language." They certainly do communicate information or give orders by some means; and when the insects stop for that purpose, they face each other and execute peculiar wavings of these organs that are highly suggestive of the movements of the old semaphore telegraph arms.

The most generally received opinion is that these antennæ are very delicate organs of touch, but some recent experiments made by Gustav Hansen indicate that they are organs of smelling or of some similar power of distinguishing objects at a distance. Flies deprived of their antennæ ceased to display any interest in tainted meat that had previously proved very attractive. Other insects similarly treated appear to become indifferent to odors generally. He shows that the development of the antennæ in different species corresponds to the power of smelling which they seem to possess.

I am sorely tempted to add another argument to those brought forward by Hansen, viz.: that our own olfactory nerves, and those of all our near mammalian relations, are curiously like a pair of antennæ.

There are two elements in a nervous structure—the gray and the white; the gray, or ganglionic portion, is supposed to be the centre or seat of nervous power, and the white medullary or fibrous portion merely the conductor of nervous energy.

The nerves of the other senses have their ganglia seated internally, and bundles of tubular white threads spread outwards therefrom; but not so with the olfactory nervous apparatus. These present two horn-like projections that are thrust forward from the base of the brain, and have white or medullary stems that terminate outwardly or anteriorly in ganglionic bulbs resting upon what I may call the roof of the nose; these bulbs throw out fibres that are composed, rather paradoxically, of more gray matter than white. In some quadrupeds with great power of smell, the olfactory nerves extend so far forward as to protrude beyond the front of the hemispheres of the brain, with bulbous terminations relatively very much larger than those of man.

They thus appear like veritable antennæ. In some of our best works on anatomy of the brain (Solly, for example) a series of comparative pictures of the brains of different animals is shown, extending from man to the cod-fish. As we proceed downwards, the horn-like projection of the olfactory nerves beyond the central hemispheres goes on extending more and more, and the relative magnitude of the terminal ganglia or olfactory lobes increases in similar order.

We have only to omit the nasal bones and nostrils, to continue this forward extrusion of the olfactory nerves and their bulbs and branches, to coat them with suitable sheaths provided with muscles for mobility, and we have the antennæ of insects. I submit this view of the comparative anatomy of these organs as my own speculation, to be taken for what it is worth.

There is no doubt that the antennæ of these creatures are connected by nerve-stalks with the anterior part of their supra-œsophageal ganglia, *i.e.*, the nervous centres corresponding to our brain.

But what kind and degree of power must such olfactory organs possess? The dog has, relatively to the rest of his brain, a much greater development of the olfactory nerves and ganglia than man has. His powers of smell are so much greater than ours that we find it difficult to conceive the possibility of what we actually see him do. As an example, I may describe an experiment I made upon a bloodhound of the famous Cuban breed. He belonged to a friend whose house is situated on an eminence commanding an extensive view. I started from the garden and wandered about a mile away, crossed several fields by sinuous courses, climbing over stiles, and jumping ditches, always keeping the house in view; I then returned by quite a different track. The bloodhound was set upon the beginning of my track. I watched him from a window galloping rapidly, and following all its windings without the least halting or hesitation. It was as clear to his nose as a gravelled path or a luminous streak would be to our eyes. On his return I went down to him, and without approaching nearer than five or six yards, he recognized me as the object of his search, proving this by circling round me, baying deeply and savagely though harmlessly, as he always kept at about the same distance.*

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* What did he smell? Was it an emanation from the soles of my feet? If so, how did this aura get through the soles of my boots,

If the difference of development between the human and canine internal antennæ produces all this difference of function, what a gulf may there be between our powers of perceiving material emanations and those possessed by insects! If my anatomical hypothesis is correct, some insects have protruding nasal organs or out-thrust olfactory nerves as long as all the rest of their bodies. The power of movement of these in all directions affords the means of sensory communication over a corresponding range, instead of being limited merely to the direction of the nostril openings. In some insects, such as the plumed gnat, the antennæ do not appear to be thus moveable, but this want of mobility is more than compensated by the multitude of branchings of these wonderful organs, whereby they are simultaneously exposed in every direction. This structure is analogous to the fixed but multiplied eyes of insects, which, by seeing all round at once, compensate for the want of that mobility possessed by others that have but a single eyeball mounted on a flexible and mobile stalk; that of the spider, for example.

Such an extension of such a sensory function is equivalent to living in another world of which we have no knowledge and can form no definite conception. We, by our senses of touch and vision, know the shapes and colors of objects, and by our very rudimentary olfactory organs form crude ideas of their chemistry or composition, through the medium of their material emanations; but the huge exaggeration of this power in the insect should supply him with instinctive perceptive powers of chemical analysis, a direct acquaintance with the inner molecular constitution of matter far clearer and deeper than we are able to obtain by all the refinements of laboratory analyses or the hypothetical formulating of molecular mathematicians. Add

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which were thick? It could scarcely have been the odor of the boot soles themselves that he followed, as he recognized me afterwards at some distance. This suggests an interesting experiment, that anybody owning one of these dogs may easily try. Make a similar track to mine, but when on the way, take off the boots you wore on starting and change them for some one else's boots, or a new pair, and watch the result from the window.

this to the other world of sensations producible by the vibratory movements of matter lying between those perceptible by our organs of hearing and vision, then strain your imagination to its cracking point, and you will still fail to picture the wonderland in which the smallest of our fellow-creatures may be living, moving, and having their being.

THE ORIGIN OF LUNAR VOLCANOES.

MANY theoretical efforts, some of considerable violence, have been made to reconcile the supposed physical contradiction presented by the great magnitude and area of former volcanic activity of the Moon, and the present absence of water on its surface. So long as we accept the generally received belief that water is a necessary agent in the evolution of volcanic forces, the difficulties presented by the lunar surface are rather increased than diminished by further examination and speculation.

We know that the lava, scoriæ, dust and other products of volcanic action on this earth are mainly composed of mixed silicates—those of alumina and lime preponderating. When we consider that the solid crust of the Earth is chiefly composed of silicic acid, and of basic oxides and carbonates which combine with silicic acid when heated, a natural necessity for such a composition of volcanic products becomes evident.

If the Moon is composed of similar materials to those of the Earth, the fusion of its crust must produce similar compounds, as they are formed independently of any atmospheric or aqueous agency.

This being the case, the phenomena presented by the cooling of fused masses of mixed silicates in the absence of water become very interesting. Opportunities of studying such phenomena are offered at our great iron-works, where fused masses of iron cinder, composed mainly of mixed silicates, are continually to be seen in the process of cooling under a variety of circumstances.

I have watched the cooling of such masses very frequently, and have seen abundant displays of miniature volcanic phenomena, especially marked where the cooling has occurred under conditions most nearly resembling those of a gradually cooling planet or satellite; that is, when the fused cinder has been enclosed by a solid resisting and contracting crust.

The most remarkable that I have seen are those presented by the cooling of the "tap cinder" from puddling furnaces. This, as it flows from the furnace, is received in stout iron boxes ("cinder-bogies") of circular or rectangular horizontal section. The following phenomena are usually observable on the cooling of the fused cinder in a circular bogie.

First a thin solid crust forms on the red-hot surface. This speedily cools sufficiently to blacken. If pierced by a slight thrust from an iron rod, the red-hot matter within is seen to be in a state of seething activity, and a considerable quantity exudes from the opening. If a bogie filled with fused cinder is left undisturbed, a veritable spontaneous volcanic eruption takes place through some portion, generally near the centre, of the solid crust. In some cases, this eruption is sufficiently violent to eject small spurts of molten cinder to a height equal to four or five diameters of the whole mass.

The crust once broken, a regular crater is rapidly formed, and miniature streams of lava continue to pour from it; sometimes slowly and regularly, occasionally with jerks and spurts due to the bursting of bubbles of gas. The accumulation of these lava-streams forms a regular cone, the height of which goes on increasing. I have seen a bogie about 10 or 12 inches in diameter, and 9 or 10 inches deep, thus surmounted by a cone above 5 inches high, with a base equal to the whole diameter of the bogie. These cones and craters could be but little improved by a modeler desiring to represent a typical volcano in miniature.

Similar craters and cones are formed on the surface of cinder which is not confined by the sides of the bogie. I have seen them well displayed on the "running-out beds" of refinery furnaces. These, when filled, form a small lake of molten iron covered with a layer of cinder. This cinder first skins over, as in the bogies, then small crevasses form in this crust, and through these the fused cinder oozes from below. The outflow from this chasm soon becomes localized, so as to form a single crater, or a small chain of craters; these gradually devolop into cones by the accumlation of outflowing lava, so that when the whole mass has solidified, it is covered more or less thickly with a number of such hillocks. These, however, are much smaller than in the former case, reaching to only one or two inches in height, with a proportionate base. It is evident that the dimensions of these miniature volcanoes are determined mainly by the depth of the molten matter from which they are formed. In the case of the bogies, they are exaggerated by the overpowering resistance of the solid iron bottom and sides, which force all the exudation in the one direction of least resistance, viz., towards the centre of the thin upper crust, and thus a single crater and a single cone of the large relative dimensions above described are commonly formed.

The magnitude and perfection of these miniature volcanoes vary considerably with the quality of the pig-iron and the treatment it has received, and the difference appears to depend upon the evolution of gases, such as carbonic oxide, volatile chlorides, fluorides, etc. I mention the fluorides particularly, having been recently engaged in making some experiments on Mr. Henderson's process for refining pig-iron, by exposing it when fused to the action of a mixture of fluoride of calcium and oxides of iron, alumina, manganese, etc. The cinder separated from this iron displayed the phenomena above described very remarkably, and jets of yellowish flame were thrown up from the craters while the lava was flowing. The flame was succeeded by dense white vapors as the temperature of the cinder lowered, and a deposit of snow-like, flocculent crystals was left upon and around the mouth or crater of each cone. The miniature representation of cosmical eruptions was thus rendered still more striking, even to the white deposit of the haloid salts which Palmieri has described as remaining after the recent eruption of Vesuvius.

The gases thus evolved have not yet been analytically examined, and the details of the powerful reactions displayed in this process still demand further study; but there can be no doubt that the combination of silicic acid with the base of the fluor spar is the fundamental reaction to which the evolution of the volatile fluorides, etc., is mainly due.

A corresponding evolution of gases takes place in cosmical volcanic action, whenever silicic acid is fused in contact with limestone or other carbonate, and a still closer analogy is presented by the fusion of silicates in contact with chlorides and oxides, in the absence of water. If the composition of the Moon is similar to that of the Earth, chlorides of sodium, etc., must form an important part of its solid crust; they should correspond in quantity to the great deposit of such salts that would be left behind if the ocean of the Earth were evaporated to dryness. The only assumptions demanded in applying these facts to the explanation of the surface configuration of the Moon are, 1st, that our satellite resembles its primary in chemical composition; 2d, that it has cooled down from a state of fusion; and 3d, that the magnitude of the eruptions, due to such fusion and cooling, must bear some relation to the quantity of matter in action.

The first and second are so commonly made and understood, that I need not here repeat the well-known arguments upon which they are supported, but may remark that the facts above described afford new and weighty evidence in their favor.

If the correspondence between the form of a freely suspended and rotating drop of liquid and that of a planet or satellite is accepted as evidence of the exertion of the same forces of cohesion, etc., on both, the correspondence between the configuration of the lunar surface, and that of small quantities of fused and freely cooled earth-crust matter, should at least afford material support to the otherwise indicated inference, that the materials of the Moon's crust are similar to those of the Earth's, and that they have been cooled from a state of fusion.

I think I may safely generalize to the extent of saying, that no considerable mass of fused earthy silicates can cool down under circumstances of free radiation without first forming a heated solid crust, which, by further radiation, cooling, and contraction, will assume a surface configuration resembling more or less closely that of the Moon. Evidence of this is afforded by a survey of the spoil-banks of blast furnaces, where thousands of blocks of cinder are heaped together, all of which will be found to have their upper surfaces (that were freely exposed when cooling) corrugated with radiating miniature lava streams, that have flowed from one or more craters or openings that have been formed in the manner above described.

The third assumption will, I think, be at once admitted, inasmuch as it is but the expression of a physical necessity.

According to this, the Earth, if it has cooled as the Moon is supposed to have done, should have displayed corresponding irregularities, and generally, the magnitude of mountains of solidified planets and satellites should be on a scale proportionate to their whole mass. In comparing the mountains of the Moon and *Mercury* with those of the Earth, a large error is commonly made by taking the customary measurements of terrestrial mountain-heights from the sea-level. As those portions of the Earth which rise above the waters are but its upper mountain slopes, and the ocean bottom forms its lower plains and valleys, we must add the greatest ocean depths to our customary measurements, in order to state the full height of what remains of the original mountains of the Earth. As all the stratified rocks have been formed by the wearing down of the original upper slopes and summits, we cannot expect to be able to recognize the original skeleton form of our water-washed globe.

If my calculation of the atmosphere of *Mercury* is correct, viz., that its pressure is equal to about one seventh of the Earth's, or 4¼ inches of mercury, there can be no liquid water on that planet, excepting perhaps over a small amount of circumpolar area, and during the extremes of its aphelion winter. Thus the irregularities of the terminator, indicating mountain elevations calculated to reach to $\frac{1}{253}$ of the diameter of the planet, are quite in accordance with the above-stated theoretical consideration.

There is one peculiar feature presented by the cones of the cooling cinder which is especially interesting. The flow of fused cinder from the little crater is at first copious and continuous; then it diminishes and becomes alternating, by a rising and falling of the fused mass within the cone. Ultimately the flow ceases, and then the inner liquid sinks, more or less, below the level of the orifice. In some cases, where much gas is evolved, this sinking is so considerable as to leave the cone as a mere hollow shell; the inner liquid having settled down and solidified with a flat or slightly rounded surface, at about the level of the base of the cone, or even lower. These hollow cones were remarkably displayed in some of the cinder of the Henderson iron, and their formation was obviously promoted by the abundant evolution of gas.

If such hollow cones were formed by the cooling of a mass like that of the Moon, they would ultimately and gradually subside by their own weight. But how would they yield? Obviously by a gradual hinge-like bending at the base towards the axis of the cone. This would occur with or without fracture, according to the degree of viscosity of the crust, and the amount of inclination. But the sides of the hollow-cone shell, in falling towards the axis, would be crushing into smaller circumferences. What would result from this? I think it must be the formation of fissures, extending, for the most part, radially from the crater towards the base, and a crumpling up of the shell of the cone by foldings in the same direction. Am I venturing too far in suggesting that in this manner may have been formed the mysterious rays and rills that extend so abundantly from several of the lunar craters?

The upturned edges or walls of the broken crust, and the chasms necessarily gaping between them, appear to satisfy the peculiar phenomena of reflection which these rays present. These edges of the fractured crust would lean towards each other, and form angular chasms; while the foldings of the crust itself would form long concave troughs, extending radially from the crater.

These, when illuminated by rays falling upon them in the direction of the line of vision, must reflect more light towards the spectator than does the general convex lunar surface, and thus they become especially visible at the full Moon.

Such foldings and fractures would occur after the subsidence and solidification of the lava-forming liquid—that is, when the formation of new craters had ceased in any given region; hence they would extend across the minor lateral craters formed by outbursts from the sides of the main cone, in the manner actually observed.

The fact that the bottoms of the great walled craters of the Moon are generally lower than the surrounding plains must not be forgotten in connection with this explanation.

I will not venture further with the speculations suggested by the above-described resemblances, as my knowledge of the details of the telescopic appearances of the Moon is but second-hand. I have little doubt, however, that observers who have the privilege of direct familiarity with such details, will find that the phenomena presented by the cooling of iron cinder, or other fused silicates, are worthy of further and more careful study.

NOTE ON THE DIRECT EFFECT OF SUN-SPOTS ON TERRESTRIAL CLIMATES.

Professor Langley determines quantitatively the effects respectively produced by the radiations from the solar spots, penumbra, and photosphere upon the face of a thermopile, and infers that these effects measure their relative influence on terrestrial climate.

In thus assuming that the heat communicated to the thermopile measures the solar contribution to terrestrial climate, Professor Langley omits an important factor, viz., the amount of heat absorbed in traversing the earth's atmosphere; and in measuring the relative efficiency of the spots, penumbra, and photosphere, he has not taken into account the variations of diathermancy of the intervening atmospheric matter, which are due to the variations in the source of heat.

Speaking generally, it may be affirmed that the radiations of obscure heat are more largely absorbed by the gases and vapors of our atmosphere than those of luminous heat, and the great differences in the mere luminosity of the spots, penumbra, and photosphere justify the assumption that the radiations of a sun-spot will (to use the expressive simile of Tyndall) lose far more by atmospheric sifting than will those from the photosphere.

But the spot areas will be none the less effective on terrestrial climate on that account. A given amount of heat arrested by the earth's atmosphere will have even greater climatic efficiency than if received upon its solid surface, inasmuch as the gases are worse radiators than the rocks, and will therefore, *cæteris paribus*, retain a larger proportion of the heat they receive.

I have long ago endeavored to show* that the depth of the photosphere, from the solar surface inwards, is limited by dissociation ; that the materials of the Sun within the photosphere exist in a dissociated, elementary condition ; that at the photosphere they are, for the most part, combined. This view has since been adopted by many eminent solar physicists, and if correct, demands a much higher temperature within the depths revealed by that withdrawal of the photospheric vail which constitutes a sun-spot.

If I am right in this, and also in supposing the spot-radiations to be so much more abundantly absorbed than those of the photosphere, and if in spite of this higher temperature of the spots, the *surface* of the earth receives from them the lower degree of heat measured by Professor Langley, another interesting consequence must follow. The excess of spot-heat directly absorbed by the atmosphere, and mainly by the water dissolved or suspended in its upper regions, must be especially effective in dissipating clouds and checking or modifying their formation. The meteorological results of this may be important, and are worthy of careful study.

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* "The Fuel of the Sun," Chapters iv. to x.

In thus venturing to question some of Professor Langley's inferences I am far from underrating the interest and importance of his researches. On the contrary, I regard the quantitative results he has obtained as especially valuable and opportune, in affording means of testing the above-named and other speculations in solar physics. Similar observations repeated at different elevations would decide, so far as the lower regions are concerned, whether or not there is any difference in the quantity of heat imparted by the bright and obscure portions of the Sun to our atmosphere. If the differences already observed by Professor Langley vary in ascending, a new means will be afforded of studying the constitution of the interior of the Sun and its relations to the photosphere. Direct evidence of selective absorption by our atmosphere may thus be obtained, which would go far towards solving one of the crucial solar problems, viz., whether the darker regions are hotter or cooler than the photosphere.

The obscure radiations from the moon must be absorbed by our atmosphere like those from the sun-spot, and may be sufficiently effective to account for the alleged dissipation of clouds by the full moon.

In both cases the climatic influence is greatly heightened by the fact that all the heat thus absorbed is directly effective in raising the temperature of the air. The action of the absorbed heat in reference to cloud-formation is directly opposite to that of the transmitted solar heat, as this reaching the surface of the earth evaporates the superficial water, and thereby produces the material of clouds. On the other hand, the heat which is absorbed by the air increases its vapor-holding capacity, and thus prevents the formation of clouds, or even effects the dissolution of clouds already formed.

THE PHILOSOPHY OF THE RADIOMETER AND ITS COSMICAL REVELATIONS.

So much speculation, and not a little extravagant speculation, has been devoted to the dynamics of the radiometer, that I feel some compunction in adding another stone to the heap, my only apology and justification for so doing being that I propose to regard the subject from a very unsophisticated point of view, and with somewhat heretical directness of vision—*i.e.*, quite irrespective of atoms, molecules, or ether, or any other specific preconceptions concerning the essential kinetics of radiant forces, beyond that of regarding such forces as affections or conditions of matter which are transmitted radially in constant quantity, and therefore obey the necessary law of radial diffusion or inverse squares.

The primary difficulty which appears to have generally been suggested by the movements of the radiometer, is the case which it seems to present of mechanical action without any visible basis of corresponding reaction: a visible tangible object pushed forward, without any visible pushing agent or resisting fulcrum against which the moving body reacts.

This difficulty has been met by the invocation of obedient and vivacious molecules of residual atmospheric matter, which have been called upon to bound and rebound between the vanes and the inner surfaces of the glass envelope of the instrument.

How is it that the advocates of these activities have not sought to verify their speculations by modifying the shape and dimensions of the exhausted glass bulb or receiver? * If the motion of the radiometer is due to such excursions and collisions, the length of excursion and the angles of collision must modify its motions; and such modification under given conditions would form a fine subject for the exercise of the ingenuity of molecular mathematicians. If their hypothetical data are sound, they should be able to predict the relative velocities or torsion-force of a series of radiometers of similar construction in all other respects, but with variable shapes and diameters of enclosing vessels.

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* Since this was written some such modifications have been made with equivocal results.

If we divest our minds of all visions of hypothetical atoms, molecules, ethers, etc., and simply look at the facts of radiation with the same humility of intellect as we usually regard gravitation, this primary difficulty of the radiometer at once vanishes. The force of gravitation is a radiant force acting somehow between, or upon, or by distant bodies; and these bodies, however far apart, act and react upon each other with mutual forces, precisely equal and exactly contrary. We conceive the sun pulling the earth in a certain direction, and receiving from the earth an equal pull in a precisely contrary direction, and we have hitherto demanded no ethereal or molecular link for the transmission of these mutually attractive forces. Why, then, should we not regard radiant repulsive energy in the same simple manner?

If we do this there is no difficulty in finding the ultimate reaction fulcrum of the radiometer vanes. It is simply the radiating body, the match, the candle, the lamp, the sun, or whatever else may be the source of the impelling radiations. According to this view, the radiant source must be repelled with precisely the same energy as the arms or pendulum of the radiometer; and it would move backward or in opposite direction if equally free to move. If, by any means, we cause the glass envelope of the radiometer to become the radiant source, it should be repelled, and may even rotate in opposite direction to the vanes, or *vice versâ*. This has been done with floating radiometers.

Viewed thus as simple matter of fact, irrespective of any preconceived kinetics of intervening media, the net result of Mr. Crookes's researches become nothing less than the discovery of a new law of nature of great magnitude and the broadest possible generality, viz., that the sun and all other radiant bodies—*i.e.*, all the materials of the universe—exert a mechanical repulsive force, in addition to the calorific, luminous, actinic, and electrical forces with which they have hitherto been credited. He has shown that this force is refrangible and dispersible, that it is outspread with the spectrum, but is most concentrated, or active, in the region of the ultra-red rays, and progressively feeblest in the violet; or, otherwise stated, it exists in closer companionship with heat than with light, and closer with light than with actinism.

According to the doctrine of exchanges, which has now passed from the domain of theory to that of demonstrated law, all bodies, whatever be their temperature, are perpetually radiating heat-force, the amount of which varies, *cæteris paribus,* with their temperature. If we now add to this generalization that all bodies are similarly radiating mechanical force and suffering corresponding mechanical reaction, the theoretical difficulties of the radiometer vanish. What must follow in the case of a freely suspended body unequally heated on opposite sides?

It must be repelled in a direction perpendicular to the surface of its hottest side. If two rockets were affixed to opposite sides of a pendant body, and were to exert unequal ejective forces, the reaction of the stronger rocket would repel the body in the opposite direction to its preponderating ejection. This represents the radiometer vane with one side blackened and the other side bright. When exposed to luminous rays the black side becomes warmer than the bright side by its active absorption and conversion of light into heat, and thus the blackened face radiates in excess and recedes.

We may regard it thus as acting by its own radiations, or otherwise as acted upon by the more powerful radiant whose rays are differentially received by the black and bright sides. These different modes of regarding the action are perfectly consistent with each other, and analogous to the two different modes of regarding gravitation, when we describe the sun as attracting the earth, or, otherwise, the earth as gravitating to the sun. Strictly speaking, neither of these descriptions is correct, as the gravitation is mutual, and the total quantity exerted between the sun and the earth is equal to the sum of their energies, but it is sometimes convenient to regard the action from a solar standpoint, and at others from a terrestrial. So with the radiometer and the strictly mutual repulsions between it and the predominating radiant.

It appears to me that this unsophisticated conception of radiant mechanical repulsive force, and its necessary mechanical reaction on the radiant body, meets all the facts at present revealed by the experiments of Mr. Crookes and others.

The attraction which occurs when the disc of the radiometer is surrounded with a considerable quantity of atmospheric matter is probably due to inequality of atmospheric pressure. The absorbing face of the disc becomes heated above the temperature of the opposite face, the film of air in contact with the warmer face rises, leaving a relatively vacuous space in front. This produces a rush of air from back to front which carries the radiometer vane with it. When the exhaustion of the radiometer is carried so far that the residual air is only just sufficiently dense to neutralize the direct repulsion of radiation, the neutral point is reached. When exhaustion is carried beyond this, repulsion predominates.

Taking Mr. Crookes's estimate of the mechanical energy of solar radiation at 32 grains per square foot, 2 cwts. per acre, 57 tons per square mile, etc., and accepting these as they are offered, *i. e.*, merely as provisional and approximate estimates, we are led to a cosmical inference of the highest importance, one that must materially modify our interpretations of some of the grandest phenomena of the universe. Although the estimated sunlight pressure upon the earth, the three thousand millions of tons, is too small a fraction of the earth's total weight to effect an easily measurable increase of the length of our year, the case is quite otherwise with the asteroids and the zones of meteoric matter revolving around the sun.

The mechanical repulsion of radiation is a superficial action, and must, therefore, vary with the amount of surface exposed, while that of gravitation varies with the mass. Thus the ratio of radiant repulsion to the attraction of gravitation goes on increasing with the subdivison of masses, and becomes an important fraction in the case of the smaller bodies of the solar system. A zone of meteorites traveling around the sun would be broken up, sifted, and sorted into different orbits, according to their diameters, if this superficial repulsion operated against gravitation without any compensating agency. Gravitation would be opposed in various degrees, neutralized, and, in the case of cosmic dust, even reversed. Comets presenting so large a surface in proportion to their mass would either be driven away altogether or forced to move in orbits utterly disobedient to present calculations. This would occur if the inter-planetary spaces were as nearly vacuous as the torsion instrument with which Mr. Crookes made his measurements.

Regarding the properties of our atmosphere only in the light of experimental data, irrespective of imaginary molecules, and their supposed gyrations or oscillations, we see at once that an inter-planetary or inter-stellar vacuum must act like a Sprengel pump upon our atmosphere, upon the atmosphere of other planets, and upon those of the sun and the stars, and would continue such action until an equilibrium between the repulsive energy of the gas and the gravitation of the solid orbs had been established. Atmospheric matter would thus be universally diffused, with special accumlations around solid orbs, varying in quantity with their respective gravitating energy. Such a universal atmosphere would accelerate orbital motion, and this acceleration would vary with the surface of bodies. Its action being thus exactly opposed to that of radiant repulsion, it must, at a certain density, exactly neutralize it. That it does this is evident from the obedience of all the elements of the solar system to the calculated action of gravitation; and thus Mr. Crookes's researches not only confirm the idea of universal atmospheric diffusion, but they afford a means by which we may ultimately measure the actual density of the universal atmosphere. If, as I have endeavored to show in my essay on "The Fuel of the Sun," the initial radiant energy of every star depends upon its mass, and its consequent condensation of atmospheric matter, the density of inter-planetary atmosphere sufficient to neutralize the radiant mechanical energy of our sun may be the same as is demanded to perform the same function for all the stars of the universe, and all their attendant worlds, comets, and meteors.

In order to prevent misunderstanding of the above, I must add that I have therein studiously assumed a negative position in reference to all hypothetical conceptions of the nature of heat, light, etc., and their modes of transmission, simply because I feel satisfied that the subject has hitherto been obscured and complicated by overstrained efforts to fit the phenomena to the excessively definite hypotheses of modern molecular mathematicians. The atoms invented by Dalton for the purpose of explaining the demonstrated laws of chemical combination performed this function admirably, and had great educational value, so long as their purely imaginary origin was kept in view; but when such atoms are treated as facts, and physical dogmas are based upon the assumption of their actual existence, they become dangerous physical superstitions. Regarding matter as continuous, *i. e.*, supposing it to be simply as it appears to be, and coextensive with the universe, in accordance with the experimental evidences of the unlimited expansibility of gaseous matter, we need only assume that our sensations of heat, light, etc., are produced by active conditions of such matter analogous to those which are proved to produce our sensations of sound. On this basis there is no difficulty in conceiving the rationale of the reaction which produces the repulsion of the radiometer. I may even go further, and affirm that it is impossible to rationally conceive radiation producing any mechanical effects without mechanical reaction. If heat be motion, and actual motion of actual matter, mechanical force must be exerted to produce it, and a body which is warmer on one side than the other, *i. e.*, which is exerting more outward motion-producing force on one side than on the other, must be subject to proportionally unequal reaction, and, therefore, if free to move, must retreat in a direction contrary to that of its greater activity. Regarded thus, the residual air of the radiometer does act, not by collisions of particles between the vane and inside of the glass vessel, but by the direct reaction of the radiant energy which would operate irrespective of vessels, *i. e.*, upon naked radiometer vanes if carried halfway to the moon, or otherwise freed from excess of atmospheric embarrassment.

The recent experiments of Mr. Crookes, showing retardation of the radiometer with extreme exhaustion, seem to indicate that heat-rays, like the electric discharge, demand a certain amount of atmospheric matter as their carrier.

I cannot conclude these hasty and imperfect notes, written merely with suggestive intent, without quoting a passage from the preface to the "Correlation of Physical Forces," which, though written so long ago, appears to me worthy of the profoundest present consideration.

"It appears to me that heat and light may be considered as affections; or, according to the undulatory theory, vibrations of matter itself, and not of a distinct ethereal fluid permeating it: these vibrations would be propagated just as sound is propagated by vibrations of wood or as waves by water. To my mind all the consequences of the undulatory theory flow as easily from this as from the hypothesis of a specific ether; to suppose which, namely, to suppose a fluid *sui generis* and of extreme tenuity penetrating solid bodies, we must assume, first, the existence of the fluid itself; secondly, that bodies are without exception porous; thirdly, that these pores communicate; fourthly, that matter is limited in expansibility. None of these difficulties apply to the modification of this theory which I venture to propose: and no other difficulty applies to it which does not equally apply to the received hypothesis."

ON THE SOCIAL BENEFITS OF PARAFFIN.

To the inhabitants of Jupiter, who have always one, two, or three of their four moons in active and efficient radiation, or of Saturn displaying the broad luminous oceans of his mighty rings in addition to the minor lamps of his eight ever-changeful satellites, the relative merits of rushlights, candles, lamps, and gaslights may be a question of indifference; but to us, the residents of a planet which has but one small moon that only displays her nearly full face during a few nights of each month, the subject of artificial light is only second in importance to those of food and artificial heat, and every step that is made in the improvement of our supplies of this primary necessary must have a momentous influence on the physical comfort, and also upon the intellectual and moral progress, of this world's human inhabitants.

If a cockney Rip Van Winkle were to revisit his old haunts, the changes produced by the introduction of gas would probably surprise him the most of all he would see. He would be astonished to find respectable people, and even unprotected females, going alone, unarmed and without fear, at night, up the by-streets which in his days were deemed so dangerous, and he would soon perceive that the bright gaslights had done more than all the laws, the magistrates, and the police, to drive out those crimes which can only flourish in darkness. The intimate connection between physical light and moral and intellectual light and progress is a subject well worthy of an exhaustive treatise.

We must, however, drop the general subject and come down to our particular paraffin lamp. In the first place, this is the cheapest light that has ever been invented—cheaper than any kind of oil lamp—cheaper than the cheapest and nastiest of candles, and, for domestic purposes, cheaper than gas. For large warehouses, shops, streets, public buildings, etc., it is not so cheap as gas should be, but is considerably cheaper than gas actually is at the price extorted by the despotism of commercial monopoly.

The reason why it is especially cheaper for domestic purposes is, first, because the small consumer of gas pays a higher price than the large consumer; and secondly, because a lamp can be placed on a table or wherever else its light is required, and therefore a small lamp flame will do the work of a much larger gas flame. We must remember that the intensity of light varies inversely with the square of the distance from the source of light; thus the amount of light received by this page from a light at one foot distance is four times as great as if it were two feet distant, nine times as great as at three feet, sixteen times as great as at four feet, one hundred times as great as at ten feet, and so on. Hence the necessity of two or three great flames in a gas chandelier suspended from the ceiling of a moderate-sized room.

In a sitting-room lighted thus with gas, we are obliged, in order to read comfortably by the distant source of light, to burn so much gas that the atmosphere of the room is seriously polluted by the products of this extravagant combustion. A lamp at a moderate distance—say eighteen inches or two feet, or thereabouts—will enable us to read or work with one-tenth to one-twentieth the amount of combustion, and therefore with so much less vitiation of the atmosphere, and, if we use a paraffin lamp, at much less expense.

But the chief value of the paraffin lamp is felt where gas is not obtainable—in the country mansion or villa, the farmhouse, and, most of all, in the poor man's cottage. We have Bible Societies for providing cheap Bibles; we have cheap standard works, cheap magazines, cheap newspapers, etc.; but all these are unavailable to the poor man until he can get a good and cheap light wherewith to read them at the only time he has for reading, viz., in the evenings, when his work is done. One shilling's worth of cheap literature will require two shillings' worth of dear candles to supply the light necessary for reading it. Therefore, the cheapening of light has quite as much to do with the poor man's intellectual progress as the cheapening of books and periodicals.

For a man to read comfortably, and his wife to do her needlework, they must have a candle for each, if dependent on tallow dips. They may, and do, struggle on with one such candle, but the inconvenience soon sickens them of their occupation; the man lolls out for an idle stroll, soon encounters a far more bright and cheerful room than the gloomy one he has just left, and, moth-like, he is attracted by the light, and finishes up his evening in the public-house.

We may preach, we may lecture, we may coax, wheedle, or anathematize, but no amount of words of any kind will render a gloomy ill-lighted cottage so attractive as the bright bar and tap-room; and human nature, irrespective of conventional distinctions of rank and class, always seeks cheerfulness after a day of monotonous toil. Fifty years ago the middle classes were accustomed to spend their evenings in taverns, but now they prefer their homes, simply because they have learned to make their homes more comfortable and attractive.

We have not yet learned how to supply the working millions with suburban villas, but if their small rooms can be made bright and cheerful during the long evenings, a most important step is made towards that general improvement of social habits which necessarily results from a greater love of home. We may safely venture to predict that the paraffin lamp will have as much influence in elevating the domestic character of the poorer classes as the street lamps have had in purging the streets of our cities from the crimes of darkness that once infested them.

A great deal has been said about the poisonous character of paraffin works. I admit that they have much to answer for in reference to trout—that the clumsy and wasteful management of certain ill-conducted works has interfered with the sport of the anglers of one or two of the trout streams of the United Kingdom—but all the assertions that have been made relative to injury to human health are quite contrary to truth.

The fact is that the manufacture of mineral oils from cannel and shale is an unusually healthful occupation. The men certainly have dirty faces, but are curiously exempt from those diseases which are most fatal among the poor. I allude to typhus fever, and all that terrible catalogue of ills usually classed under the head of zymotic diseases. This has been strikingly illustrated in the Flintshire district. The very sudden development of the oil trade in the neighborhood of Leeswood caused that little village and the scattered cottages around to be crowded to an extent that created the utmost alarm among all who are familiar with the results of such overcrowding in poor, ill-drained, and ill-ventilated cottages. Rooms were commonly filled with lodgers who economized the apartments on the Box and Cox principle, the night workers sleeping during the day, and the day workers during the night, in the same beds. The extent to which this overcrowding was carried in many instances is hardly credible.

Mr. R. Platt, who is surgeon to most of the collieries and oilworks of this district, reports that Leeswood has enjoyed a singular immunity from typhus and fever—that, during a period when it was prevalent as a serious epidemic among the agricultural population living on the slopes of the surrounding mountains, no single case occurred among the oil-making population of Leeswood, though its position and overcrowding seemed so directly to court its visitation. If space permitted I might give further illustrations in reference to allied diseases.

There is no difficulty in accounting for this. Carbolic acid, one of the most powerful of our disinfectants, is abundantly produced in the oilworks, and this is carried by the clothes of the men, and with the fumes of the oil, into the dwellings of the workmen and through all the atmosphere of the neighborhood, and has thereby counteracted some of the most deadly agencies of organic poisons. Besides this, the paraffin oil itself is a good disinfectant.

Even the mischief done to the trout is more than counterbalanced by the destruction of those mysterious fungoid growths which result from the admixture of sewage matter with the water of our rivers, and are so destructive to human health and life. The carbolic acid and paraffin oil, in destroying these as well as the trout, are really acting as great purifiers of the river, so that, after all, the only interest that has suffered is the sporting interest. This same interest has otherwise suffered. The old haunts of the snipe and woodcock, of partridges, hares, and pheasants, are being ruthlessly and barbarously destroyed, and—horrible to relate—hundreds of cottages, inhabited by vulgar, hard-handed, thick-booted human beings, are taking their place. Churches are being extended, school-houses and chapels built; penny readings, lectures, concerts, etc., are in active operation, and even drinking fountains are in course of construction; but the trout have suffered and the woodcocks are gone.

We may thus measure the good against the evil as it stands here in the headquarters of oil-making, and should add to one side the advantages which the cheap and brilliant light affords—advantages which we might continue to enumerate, but they are so obvious that it is unnecessary to go further.

There is one important and curious matter which must not be omitted. This, like the moral and intellectual advantages of the cheap paraffin light, has hitherto remained unnoticed, viz., that the introduction of mineral oils and solid paraffin for purposes of illumination and lubrication has largely increased the world's supply of food.

This may not be generally obvious at first sight; but to him, who, like the writer, has had many a supper at an Italian osteria with peasants and carbonari, it is obvious enough. He will remember how often he has seen the lamp that has lighted himself and companions to their supper filled from the same flask as supplied the salad which formed so important a part of the supper itself. Throughout the South of Europe salads are most important elements of national food, and when thus abundantly eaten the oil is quite necessary, the oil is also used for many of the cookery operations where butter is used here, and this same olive oil has hitherto been the chief, and in some places the sole, illuminating agent. The poor peasant of the South looks jealously at his lamp, and feeds its stingily, for it consumes his richest and choicest food, and, if well supplied, would eat as much as a fair-sized baby.

The Russian peasant and other Northern people have a similar struggle in the matter of tallow. It is their choicest dainty, and yet, to their bitter grief, they have been compelled to burn it. Hundreds and thousands of tons of this and of olive oil have been annually consumed for the lubrication of our steam engines and other machines. A better time is approaching now that paraffin lamps are so rapidly becoming the chief illuminators of the whole civilized world, superseding the crude tallow candle and the antique olive-oil lamp, while, at the same time, the tallow candle is gradually being replaced by the beautiful sperm-like parffin candle; and, in addition to this, the greedy engines that have consumed so much of the olive oil and the tallow are learning to be satisfied with lubricators made from minerals kindred to themselves.

The peasants of the sunny South will feed upon salads made doubly unctuous and nutritious by the abundant oil; their fried meats, their pastry, omelettes, and sauces will be so much richer and better than heretofore, and the Russian will enjoy more freely his well-beloved and necessary tallow, when the candle is made and the engine lubricated with the fat extracted from coals and stones which no human stomach can envy. I might travel on to China and tell of the work that paraffin and paraffin oils have yet to do among the many millions there and in other countries of the East. The great wave of mineral light has not yet fairly broken upon their shores; but when it has once burst through the outer barriers, it will, without doubt, advance with great rapidity, and with an influence whose beneficence can scarcely be exaggerated.

(The above was written in the early days of paraffin lamps, and while the writer was engaged in the distillation of paraffin oils, etc., from the Leeswood cannel. These are now practically superseded by American petroleum of similar composition, but distilled in Nature's oilworks. The anticipations that appeared Utopian at the time of writing have since been fully realized, or even exceeded, as the wholesale price of mineral oil has fallen from two shillings per gallon to an average of about eightpence, and lamps have been greatly improved. At this price the cost of maintaining a light of given power in an ordinary lamp is about equal to that of ordinary London gas, if it were supplied at one shilling per thousand cubic feet. The mineral oil, being a fine hydrocarbon, does far less mischief than gas by its combustion, as may be proved by warming a conservatory with a paraffin stove and another with a stove. In the latter all the delicate plants will be killed; in the first they scarcely suffer at all. If these facts were generally understood we should be in a better position for battle with the gas monopolies. The importation of petroleum to the

United Kingdom during the first five months of 1882 amounted to 26,297,346 gallons.)

THE SOLIDITY OF THE EARTH.

In his opening address to the Mathematical and Physical Section of the British Association, Sir William Thomson affirmed, "with almost perfect certainty, that, whatever may be the relative densities of rock, solid and melted, or at about the temperature of liquefaction, it is, I think, quite certain that cold solid rock is denser than hot melted rock; and no possible degree of rigidity in the crust could prevent it from breaking in pieces and sinking wholly below the liquid lava," and that "this process must go on until the sunk portions of the crust build up from the bottom a sufficiently close-ribbd skeleton or frame, to allow fresh incrustations to remain bridged across the now small areas of lava-pools or lakes."*

This would doubtless be the case if the material of the earth were chemically homogeneous or of equal specific gravity throughout, and if it were chemically inert in reference to its superficial or atmospheric surroundings. But such is not the case. All we know of the earth shows that it is composed of materials of varying specific gravities, and that the range of this variation exceeds that which is due to the difference between the theoretical internal heat of the earth and its actual surface temperature.

We know by direct experiment that these materials, when fused together, arrange themselves according to their specific gravities, with the slight modification due to their mutual diffusibilities. If we take a mixture of the solid elements of which the earth, so far as we know it, is composed, fused them, and leave them exposed to atmospheric action, what will occur?

The heavy metals will sink, the heaviest to the bottom, the lighter metals (*i.e.*, those that we call the metals of the earths, because they form the basis of the earth's superficial crust) will rise along with the silicon, etc., to the surface; these and the silicon will oxidize and combine, forming silicates, and with a sufficient supply of carbonic acid, some of them, such as calcium, magnesium, etc., will form carbonates when the temperature sinks below that of the dissociation of such compounds.

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* *Nature*, vol. xiv. p. 429.

The scoria thus formed will float upon the heavy metals below and protect them from cooling by resisting their radiation; but if in the course of contraction of this crust some fissures are formed reaching to the melted metals below, the pressure of the floating solid will inject the fluid metal upwards into these fissures to a height corresponding to the flotation depth of the solid, and thus form metallic veins permeating the lower strata of the crust. I need scarcely add that this would rudely but fairly represent what we know of the earth.

But it may be objected that I only describe an imaginary experiment. This is true as regards the whole of the materials united in a single fusion. Nobody has yet produced a complete model with platinum and gold in the centre, and all the other metals arranged in theoretical order with the oxidized, silicated, and carboneted crust outside; but with a limited number of elements this has been done, is being done daily, on a scale of sufficient magnitude to amply refute Sir William Thomson's description of a fused earth solidifying from the centre outwards.

This refutation is to be seen in our blast furnaces, refining furnaces, puddling furnaces, Bessemer ladles, steel melting-pots, cupels, foundry crucibles; in fact, in almost every metallurgical operation down to the simple fusion of lead or solder in a plumber's ladle, with its familiar floating crust of dross or oxide.

As an example I will, on account of its simplicity, take the open hearth finery and the refining of pig-iron. Here a metallic mixture of iron, silicon, carbon, sulphur, etc., is simply fused and exposed to the superficial action of atmospheric air. What is the result?

Oxidation of the more oxidizable constituents takes place, and these oxides at once arrange themselves according to their specific gravities. The oxidized carbon forms atmospheric matter and rises above all as carbonic acid, then the oxidized silicon, being lighter than the iron, floats above that, and combines with aluminium or calcium that may have been in the pig and with some of the iron; thus forming a silicious crust closely resembling the predominating material of the earth's crust.

When the oxidation in the finery is carried far enough, the melted material is tapped out into a rectangular basin or mould, usually about 10 feet long and about 3 feet wide, where it settles and cools. During this cooling the silica and silicates—*i.e.*, the rock matter—separate from the metallic matter and solidify on the surface as a thin crust, which behaves in a very interesting and instructive manner. At first a mere skin is formed. This gradually thickens, and as it thickens and cools becomes corrugated into mountain chaines and valleys much higher and deeper, in proportion to the whole mass, than the mountain chains and valleys of our planet. After this crust has thickened to a certain extent volcanic action commences. Rifts, dykes, and faults are formed by the shrinkage of the metal below, and streams of lava are ejected. Here and there these lava streams accumulate around their vent and form insolated conical volcanic mountains with decided craters, from which the eruption continues for some time. These volcanoes are relatively far higher than Chimborazo. The magnitude of these actions varies with the quality of the pig-iron.

The open hearth finery is now but little used, but probably some are to be seen at work occasionally in the neighborhood of Glasgow, and I am sure that Sir William Thomson will find a visit to one of them very intresting. Failing this, he may easily make an experiment by tapping into a good-sized "cinder bogie" some melted pig-iron from a pudding furnace (taking it just before the iron "comes to nature"), and leaving the melted mixture to cool slowly and undisturbed.

The cinder of the blast furnace, which in like manner floats on the top of the melted pig-iron, resembles still more closely the prevailing rock-matter of the earth, on account of the larger proportion, and the varied compounds, of earth-metals it contains.

For the volcanic phenomena alone he need simply watch what occurs when in the ordinary course of puddling the cinder is run into a large bogie, and the bogie is left to cool standing upright. I need scarcely add that these phenomena strikingly illustrate and confirm Mr. Mallett's theory of earthquakes, volcanoes, and mountain-formation.

In merely passing through an iron-making district one may see the results of what I have called the volcanic action, by simply observing the form of those oyster-shaped or cubical blocks of cinder that are heaped in the vicinity of every blast furnace that has been at work for some time. Radial ridges or consolidated miniature lava-streams are visible on the exposed face of nearly, if not quite all of these. They were ejected or squeezed up from below while the mass was cooling, when the outer crust had consolidated but the inner portion still remained liquid. Many of these are large enough, and sufficiently well-marked, to be visible from a railway carriage passing a cinder heap near the road.*

A CONTRIBUTION TO THE HISTORY OF ELECTRIC LIGHTING.

As the subject of lighting by electricity is occupying so much public attention, and the merits of various inventors and inventions are so keenly discussed, the following facts may have some historical interest in connection with it.

In October, 1845, I was consulted by some American gentlemen concerning the construction of a large voltaic battery for experimenting upon an invention, afterwards described and published in the specification of "King's Patent Electric Light' (Letters Patent granted for Scotland, November 26, 1845; enrolled March 25, 1846; English Patent sealed November 4, 1845).

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* See Chapter on "The Origin of Lunar Volcanoes."

Mr. King was not the inventor, but he and Mr. Dorr supplied capital, and Mr. Snyder also held a share, which was afterwards transferred to myself. The inventor was Mr. Starr, a young man about twenty-five years of age, and one of the ablest experimental investigators with whom I have ever had the privilege of near acquaintance.

He had been working for some years on the subject, commencing with the ordinary arc between charcoal points. His first efforts were directed to maintaining constancy, and he showed me, in January of 1846, an arrangement by which he succeeded in effecting an automatic renewal of contact by means of an electro-magnet, the armature of which received the electric flow, when the arc was broken, and which thus magnetized brought the carbons together and then allowed them to be withdrawn to their required separation, when the flow returned. This device was almost identical with that subsequently re-invented and patented by Mr. Staite (quite independently, I believe), and which, with modifications, has since been rather extensively used.

Although successful so far, he was not satisfied. He reasoned out the subject, and concluded that the electric spark between metals, the electric arc between the carbons, and other luminous electric phenomena are secondary effects due to the heating and illumination of electric carriers; that the electric spark of the conductors of ordinary electrical machines is simply a transfer of incandescent particles of metal, which effect a kind of electric convection, known as the disruptive discharge; and that the more brilliant arc between the carbon points is simply due to the use of a substance which breaks up more readily, and gives a longer, broader, and more continuous stream of incandescent convection particles.

This is now readily accepted, but at that time was only dawning upon the understanding of electricians. I am satisfied that Mr. Starr worked out the principle quite originally. He therefore concluded that, the light being due to solid particles heated by electric disturbance, it would be more advantageous—as regards steadiness, economy, and simplicity—to place in the current a continuous solid barrier, which should present sufficient resistance to its passage to become bodily incandescent without disruption.

This was the essence of the invention specified in King's Patent as "a communication from abroad," which claims the use of continuous metallic and carbon conductors, intensely heated by the passage of a current of electricity, for the purposes of illumination.

The metal selected was platinum, which, as the specification states, "though not so infusible as iridium, has but little affinity for oxygen, and offers a great resistance to the passage of the current." The form of thin sheets known by the name of leaf-platinum is described as preferable. These to be rolled between sheets of copper in order to secure uniformity, and to be carefully cut in strips of equal width, and with a clean edge, in order that one part may not be fused before the other parts have obtained a sufficiently high temperature to produce a brilliant light. This strip to be suspended between forceps.

I need not describe the arrangement for regulating the distance between the forceps, for directing the current, etc., as we soon learned that this part of the invention was of no practical value, on account of the narrow margin between efficient incandescence and the fusion of the platinum. The experiments with the large battery that I made—consisting of 100 Daniell cells, with two square feet of working surface of each element in each cell, and the copper-plates about three-quarters of an inch distant from the zinc—satisfied all concerned that neither platinum nor any available alloy of platinum and iridium could be relied upon; especially when the grand idea of subdividing the light by interposing several platinum strips in the same circuit, and working with a proportionally high power, was carried out.

This drove Mr. Starr to rely upon the second part of the specification, viz., that of using a small stick of carbon made incandescent in a Torricellian vacuum. He commenced with plumbago, and, after trying many other forms of carbon, found that which lines gas-retorts that have been long in use to be the best.

The carbon stick of square section, about one tenth of an inch thick and half an inch working length, was held vertically, by metallic forceps at each end, in a barometer tube, the upper part of which, containing the carbon, was enlarged to a sort of oblong bulb. A thick platinum wire from the upper forceps was sealed into the top of the tube and projected beyond; a similar wire passed downwards from the lower forceps, and dipped into the mercury of the tube, which was so long that when arranged as a barometer the enlarged end containing the carbon was vacuous.

Considerable difficulty was at first encountered in supporting this fragile stick. Metallic supports were not available, on account of their expansion; and, finally, little cylinders of porcelain were used, one on each side of the carbon stick, and about three eighths of an inch distant.

By connecting the mercury cup with one terminal of the battery, and the upper platinum-wire with the other, a brilliant and perfectly steady light was produced, not so intense as the ordinary disruption arc between carbons, but equally if not more effective, on account of the magnitude of brilliant radiating surface.

Some curious phenomena accompanied this illumination of the carbon. The mercury column fell to about half its barometric height, and presently the glass opposite the carbon stick became slightly dimmed by the deposition of a thin film of sooty deposit.

At first the depression of the mercury was attributed to the formation of mercurial vapor, and is described accordingly in the specification; but further observation refuted this theory, for no return of the mercury took place when the tube was cooled. The depression was permanent. The formation of vaporous carbon was suggested by one of the capitalists; but neither Mr. Starr nor myself was satisfied with this, nor with any other surmise we were able to make during Mr. Starr's lifetime, nor up to the period of final abandonment of the enterprise.

When this occurred the remaining apparatus was assigned to me, and I retained possession of the finally arranged tube and carbon for many years, and have shown it in action worked by a small Grove's battery in the Town

Hall of Birmingham, and many times to my pupils at the Birmingham and Midland Institute.

These exhibitions suggested an explanation of the mysterious gaseous matter, which I believe to be the correct one, and also of the carbon deposit. It is this:—That the carbon contains occluded oxygen; that when the carbon is heated some of this oxygen combines with the carbon, forming carbonic oxide and carbonic acid, and a little smoke. I proved the presence of carbonic acid by the usual tests, but did not quantitatively determine its proportion of the total atmosphere.

If I were fitting up another tube on this principle I should wash it with a strong solution of caustic potash before filling with mercury, and allow some of the potash solution to float on the mercury surface, by filling the tube while the glass remained moistened with the solution. My object would be to get rid of the carbonic acid as soon as formed, as the observations I have made lead me to believe that—when the carbon stick is incandescent in an atmosphere of carbonic acid or carbonic oxide—a certain degree of dissociation and re-combination is continually occurring, which weakens and would ultimately break up the carbon stick, and increases the sooty deposit.

The large battery was arranged for intensity, but even then it was found that the quantity (I use the old-fashioned terms) of electricity was excessive, and that it worked more advantageously when the cells were but partially filled with acid and sulphate. A larger stick of carbon might have been used with the whole surface in full action.

After working the battery in various ways, and duly considering the merits of the other forms of battery then in use, Mr. Starr was driven to the conclusion that for the purposes of practical illumination the voltaic battery is a hopeless source of power, and that magneto-electric machinery driven by steam-power must be used. I fully concurred with him in this conclusion, so did Mr. King, Mr. Dorr, and all concerned.

Mr. Starr then set to work to devise a suitable dynamo-electric machine, and, following his usual course of starting from first principles, concluded that all the armatures hitherto constructed were defective in one fundamental element of their arrangement. The thick copper wire surrounding the soft iron core necessarily follows a spira course, like that of a coarse screw-thread; but the electri current or lines of force, which it is designed to pick u and carry, circulate at right angles to the axis of the core, and extend to some distance beyond its surface. The problem thus presented is to wind around the soft iron a conductor that shall be broad enough to grasp a large proportion of this outspread force, and yet shall follow its course as nearly as possible by standing out at right angles to the axis of the armature. This he endeavored to effect by using a core of square section, and winding round it a broad ribbon of sheet copper, insulated on both sides by cementing on its surfaces a layer of silk ribbon. This armature was laid with one edge against one side of the core, and carried on thus to the angle; then turned over so that its opposite edge should be presented to the next side of the core; this side to be followed in like manner, the ribbon similarly turned again at the next corner, and so on till the core became fully enclosed or armed with the continuous ribbon, which thus encircled the core with its edges outwards, and nearly at right angles to the axis, in spite of its width, which might be increased to any extent found by experiment to be desirable.

At this stage my direct co-operation and confidential communication with Mr. Starr ceased, as I remained in London while he went to Birmingham in order to get his machinery constructed, and to apply it at the works of Messrs. Elkington, who had then recently introduced the principle of dynamo-electric motive-power for electro-plating, etc., and were, I believe, using Woolrich's apparatus, the patent for which was dated August 1, 1842, and enrolled February 1, 1843.

I am unable to state the results of his efforts in Birmingham. I only heard the murmurs of the capitalists, who loudly complained of expenditure without results. They had dreamed the same dream that Mr. Edison has recently re-dreamed, and has told the world so loudly. They supposed that the mechanically excited current might be carried along great lengths of wire, and the carbons interposed wherever required, and that the same electricity would flow on and do the duty of illumination over and over again as a river may fall over a succession of weirs and turn water-wheels at each. Mr. Starr knew better; his scepticism was misinterpreted; he was taunted with failure and non-fulfilment of the anticipations he had raised, and with the fruitless expenditure of large sums of other people's money. He was a high-minded, honorable, and very sensitive man, suffering already from overworked brain before he went to Birmingham. There he worked again still harder, with further vexation and disappointment, until one morning he was found dead in his bed. Having, during my short acquaintance with him, enjoyed his full confidence in reference to all his investigations, I have no hesitation in affirming that his early death cut short the career of one who otherwise would have largely contributed to the progress of experimental science, and have done honor to his country.

His martyrdom, for such it was, taught me a useful lesson I then much needed, viz., to abstain from entering upon a costly series of physical investigations without being well assured of the means of completing them, and, above all, of being able to afford to fail.

There are many others who sorely need to be impressed with the same lesson, especially at this moment and in connection with this subject.

The warning is the most applicable to those who are now misled by a plausible but false analogy. They look at the progress made in other things, the mighty achievements of modern Science, and therefore infer that the electric light —even though unsuccessful hitherto—may be improved up to practical success, as other things have been. A great fallacy is hidden here. As a matter of fact the progress made in electric lighting since Mr. Starr's death, in 1846, has been very small indeed. As regards the lamp itself no progress whatever has been made. I am satisfied that Starr's continuous carbon stick, properly managed in a true vacuum, or an atmosphere free from oxygen, carbonic oxide, carbonic acid, or other oxygen compound, is the best that has yet been placed before the public for all purposes where exceptionally intense illumination (as in lighthouses) is not demanded.*

Comparing electric with gas-lighting, the hopeful believers in progressive improvement appear to forget that gas-making and gas-lighting are as susceptible of further improvement as electric lighting, and that, as a matter of fact, its practical progress during the last forty years is incomparably greater than that of the electric light. I refer more particularly to the practical and crucial question of economy. The bi-products, the ammoniacal salts, the liquid hydrocarbons, and their derivatives, have been developed into so many useful forms by the achievements of modern chemistry, that these, with the coke, are of sufficient value to cover the whole cost of manufacture, and leave the gas itself as a volatile residuum that costs nothing. It would actually and practically cost nothing, and might be profitably delivered to the burners of gas consumers (of far better quality than now supplied in London) at one shilling per thousand cubic feet, if gas making were conducted on sound commercial principles,—that is, if it were not a corporate monopoly, and were subject to the wholesome stimulating influence of free competition and private enterprise. As it is, our gas and the price we pay for it are absurdities; and all calculations respecting the comparative cost of new methods of illumination should be based not on what we *do* pay per candle-power of gas-light, but what we *ought* to pay and *should* pay if the gas companies were subjected to desirable competition, or visited with the national confiscation I consider they deserve.

Having had considerable practical experience in the commercial distillation of coal for the sake of its liquid and solid hydrocarbons, I speak thus plainly and with full confidence.

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*The burnt card, burnt bamboo, and other flimsy incandescent threads now (1882) in vogue, merely represent Starr's preliminary failures prior to his adoption of the hard adamantine stick of retort-carbon, which I suppose will be duly re-invented, patented again, and form the basis of new Limited Companies, when the present have collapsed.

There is yet another consideration, and one of vital importance, to be taken into account, viz., that—whether we use the electric light derived from a dynamo-electric source, or coal-gas—our primary source of illuminating power is coal, or rather the chemical energy derivable from the combination of its hydrogen and carbon with oxygen. Now this chemical energy is a limited quantity, and the progress of Science can no more increase this quantity than it can make a ton of coal weigh 21 cwts. by increasing the quantity of its gravitating energy.

The demonstrable limit of scientific possibilities is the economical application of this limited store of energy, by converting it into the demanded form of force without waste. The more indirect and roundabout the method of application, the greater must be the loss of power in the course of its transfer and conversion. In heating the boiler that sets the dynamo-electric machine to work, about one-half the energy of the coal is wasted, even with the best constructed furnaces. This merely as regards the quantity of water evaporated. In converting the heat-force into mechanical power—raising the piston, etc., of the steam-engine—this working half is again seriously reduced. In further converting this residuum of mechanical power into electrical energy, another and considerable loss is suffered in originating and sustaining the motion of the dynamo-electric machine, in the dissipation of the electric energy that the armature cannot pick up, and in overcoming the electrical resistances to its transfer.

I am unable to state the amount of this loss in trustworthy figures, but should be very much surprised to learn that, with the best arrangements now known, more than one-tenth of the original energy of the coal is made practically available. This small illuminating residuum may, and doubtless will, be increased by the progress of practical improvement; but from the necessary nature of the problem, the power available for illumination at the end of the series must always be but a small portion of that employed at the beginning.

In burning the gas derived from coal we obtain its illuminating power *directly*, and if we burn it properly we obtain nearly all. The coke residuum is also directly used as a source of heat. The chief waste of the original energy in the gas-works is represented by that portion of the coke that is burned under the retorts, and in obtaining the relatively small amount of steam-power demanded in the works. These are far more than paid for by the value of the liquid hydrocarbons and the ammonia salts, when they are properly utilized.

In concluding my narrative, I may add that after Mr. Starr's death the patentees offered to engage me on certain terms to carry on his work. I declined this, simply because I had seen enough to convince me of the impossibility of any success at all corresponding to their anticipations. During the intervening thirty years I have abstained from further meddling with the electric light, because all that I had seen then, and have heard of since, has convinced me that—although as a scientific achievement the electric light is a splendid success—its practical application to all purposes where cost is a matter of serious consideration is hopeless, and must of necessity continue to be so.

Whoever can afford to pay some shillings per hour for a single splendid light of solar completeness can have it without difficulty, but not so where the cost in pence per hour per burner has to be counted.

I should add that before the publication of King's specification, Mr. (now Sir William) Grove proposed the use of a helix or coil of platinum, made incandescent by electricity, as a light to be used for certain purposes. This was shown at the Royal Society on or about December 1, 1845.

Since the publication of the above in 1879, I have learned, from a paper in the "Quarterly Journal of Science," by Professor Ayrton, that in 1841 an English patent was granted to De Moylens for electric lighting by incandescence.

THE FORMATION OF COAL.

In the course of a pedestrian excursion made in the summer of 1855 I came upon the Aachensee, one of the lakes of North Tyrol, rarely visited by tourists. It is situated about 30 miles N.E. of Innispruck, and fills the basin of a deep valley, the upper slopes of which are steep and richly wooded. The water of this lake is remarkably transparent and colorless. With one exception, that of the Fountain of Cyane—a deep pool forming the source of the little Syracusan river—it is the most transparent body of water I remember to have seen. This transparency revealed a very remarkable sub-aqueous landscape. The bottom of the lake is strewn with branches and trunks of trees, which in some parts are in almost forest-like profusion. As I was alone in a rather solitary region, and carrying only a satchel of luggage, my only means of further exploration were those afforded by swimming and diving. Being an expert in these, and the July summer day very calm and hot, I remained a long time in the water, and, by swimming very carefully to avoid ripples, was able to survey a considerable area of the interesting scene below.

The fact which struck me the most forcibly, and at first appeared surprising, was the upright position of many of the large trunks, which are of various lengths—some altogether stripped of branches, others with only a few of the larger branches remaining. The roots of all these are more or less buried, and they present the appearance of having grown where they stand. Other trunks were leaning at various angles and partly buried, some trunks and many branches lying down.

On diving I found the bottom to consist of a loamy powder of gray color, speckled with black particles of vegetable matter—thin scaly fragments of bark and leaves. I brought up several twigs and small branches, and with considerable difficulty, after a succession of immersions, succeeded in raising a branch about as thick as my arm and about eight feet long, above three-fourths of which was buried, and only the end above ground in the water. My object was to examine the condition of the buried and immersed wood, and I selected this as the oldest piece I could reach.

I found the wood very dark, the bark entirely gone, and the annual layers curiously loosened and separable from each other, like successive rings of bark. This continued till I had stripped the stick to about half of its original thickness, when it became too compact to yield to further stripping.

This structure apparently results from the easy decomposition of the remains of the original cambium of each year, and may explain the curious fact that so many specimens of fossilized wood exhibit the original structure of the stem, although all the vegetable matter has been displaced by mineral substances. If this stem had been immersed in water capable of precipitating or depositing mineral matter in very small interstices, the deposit would have filled up the vacant spaces between these rings of wood as the slow decomposition of the vegetable matter proceeded. At a later period, as the more compact wood became decomposed, it would be substituted by a further deposit, and thus concentric strata would be formed, presenting a mimic counterpart of the vegetable structure.

The stick examined appeared to be a branch of oak, and was so fully saturated with water that it sank rapidly upon being released.

On looking around the origin of this sub-aqueous forest was obvious enough. Here and there the steep wooded slopes above the lake were broken by long alleys or downward strips of denuded ground, where storm torrents, or some such agency, had cleared away the trees and swept most of them into the lake. A few uprooted trees lying at the sides of these bare alleys told the story plainly enough. Most of these had a considerable quantity of earth and stones adhering to their roots: this explains the upright position of the trees in the lake.

Such trees falling into water of sufficient depth to enable them to turn over must sink root downwards, or float in an upright position, according to the quantity of adhering soil. The difference of depth would tend to a more rapid penetration of water in the lower parts, where the pressure would be greatest, and thus the upright or oblique position of many of the floating trunks would be maintained till they absorbed sufficient water to sink altogether.

It is generally assumed that fossil trees which are found in an upright position have grown on the spot where they are found. The facts I have stated show that this inference is by no means necessary, not even when the roots are attached and some soil is found among them. In order to account for the other surroundings of these fossil trees a very violent hypothesis is commonly made, viz., that the soil on which they grew sank down some hundreds of feet without disturbing them. This demands a great strain upon the scientific imagination, even in reference to the few cases where the trees stand perpendicular. As the majority slope considerably the difficulty is still greater. I shall presently show how trees like those immersed in Aachensee may have become, and are now becoming, imbedded in rocks similar to those of the Coal Measures.

In the course of subsequent excursions on the fjords of Norway I was reminded of the sub-aqueous forest of the Aachensee, and of the paper which I read at the British Association meeting of 1865, of which the above is an abstract—not by again seeing such a deposit under water, for none of the fjords approach the singular transparency of the lake, but by a repetition on a far larger scale of the downward strips of denuded forest-ground. Here, in Norway, their magnitude justifies me in describing them as vegetable avalanches. They may be seen on the Sognefjord, and especially on those terminal branches of this great estuary, of which the steep slopes are well wooded. But the most remarkable display that I have seen was in the course of the magnificent, and now easily made, journey up the Storfjord and its extension and branches, the Slyngsfjord, Sunelvsfjord, Nordalsfjord, and Geirangerfjord. Here these avalanches of trees, with their accompaniment of fragments of rock, are of such frequent occurrence that sites of the farm-houses are commonly selected with reference to possible shelter from their ravages. In spite of this they do not always escape. In the October previous to my last visit a boat-house and boat were swept away; and one of the most recent among the tracks that I saw reached within twenty yards of some farm-buildings.

What has become of the millions of trees that are thus falling, and have fallen, into the Norwegian fjords during the whole of the present geological era? In considering this question we must remember that the mountain slopes forming the banks of these fjords continue downwards under the waters of the fjords which reach to depths that in some parts are to be counted in thousands of feet.

It is evident that the loose stony and earthy matter that accompanies the trees will speedily sink to the bottom and rest at the foot of the slope somewhat like an ordinary subaerial talus, but not so the trees. The impetus of their fall must launch them afloat and impel them towards the middle of the estuary, where they will be spread about and continue floating, until by saturation they become dense enough to sink. They will thus be pretty evenly distributed over the bottom. At the middle part of the estuary they will form an almost purely vegetable deposit, mingled only with the very small portion of mineral matter that is held in suspension in the apparently clear water. This mineral matter must be distributed among the vegetable matter in the form of impalpable particles having a chemical composition similar to that of the rocks around. Near the shores a compound deposit must be formed consisting of trees and fragments of leaves, twigs, and other vegetable matter mixed with larger proportions of the mineral *débris*.

If we look a little further at what is taking place in the fjords of Norway we shall see how this vegetable deposit will ultimately become succeeded by an overlying mineral deposit which must ultimately constitute a stratified rock.

All these fjords branch up into inland valleys down which pours a brawling torrent or a river of some magnitude. These are more or less turbid with glacier mud or other detritus, and great deposits of this material have already accumulated in such quantity as to constitute characteristic modern geological formations bearing the specific Norsk name of *ören*, as *Laerdalsören*, *Sundalsören*, etc., describing the small delta plains at the mouth of a river where it enters the termination of the fjord, and which, from their exceptional fertility, constitute small agricultural settlements bearing these names, which signify the river sands of *Laerdal, Sundal,* etc. These deposits stretch out into the fjord, forming extensive shallows that are steadily growing and advancing further and further into the fjord. One of the most remarkable examples of such deposits is that brought by the Storelv (or Justedals Elv), which flows down the Justedal, receiving the outpour from its glaciers, and terminates at Marifjören. When bathing here I found an extensive sub-aqueous plain stretching fairly across that branch of the Lyster fjord into which the Storelv flows. The waters of the fjord are whitened to a distance of two or three miles beyond the mouth of the river. These deposits must, if the present conditions last long enough, finally extend to the body, and even to the mouth, of the fjords, and thus cover the whole of the bottom vegetable bed with a stratified rock in which will be entombed, and well preserved, isolated specimens of the trees and other vegetable forms corresponding to those accumulated in a thick bed below, but which have been lying so long in the clear waters that they have become soddened into homogeneous vegetable pulp or mud, only requiring the pressure of solid superstratum to convert them into coal.

The specimens of trees in the upper rock, I need scarcely add, would be derived from the same drifting as that which produced the lower pulp; but these coming into the water at the period of its turbidity and of the rapid deposition of mineral matter, would be sealed up one by one as the mineral particles surrounding it subsided. Fossils of estuarine animals would, of course, accompany these, or of fresh-water animals where, instead of a fjord, the scene of these proceedings is an inland lake. In reference to this I may state that at the inner extremities of the larger Norwegian fjords the salinity of the water is so slight that it is imperceptible to taste. I have freely quenched my thirst with the water of the Sörfjord, the great inner branch of the Hardanger, where pallid specimens of bladder wrack were growing on its banks.

In the foregoing matter-of-fact picture of what is proceeding on a small scale in the Aachensee, and on a larger in Norway, we have, I think, a natural history of the formation, not only of coal seams, but also of the Coal Measures around and above them.

The theory which attributed our coal seams to such vegetable accumulations as the rafts of the Mississippi is now generally abandoned. It fails to account for the state of preservation and the position of many of the vegetable remains associated with coal.

There is another serious objection to this theory that I have not seen expressed. It is this: rivers bringing down to their mouths such vegetable deltas as are supposed, would also bring considerable quantities of earthy matter in suspension, and this would be deposited with the trees. Instead of the 2 or 3 per cent of incombustible ash commonly found in coal, we should thus have a quantity more nearly like that found in bituminous shales which may thus be formed, viz., from 20 to 80 per cent.

The alternative hypothesis now more commonly accepted —that the vegetation of our coal-fields actually grew where we find it—is also refuted by the composition of coal-ash. If the coal consisted simply of the vegetable matter of buried forests its composition should correspond to that of the ashes of plants; and the refuse from our furnaces and fireplaces would be a most valuable manure. This we know is not the case. Ordinary coal-ash, as Bischof has shown, nearly corresponds to that of the rocks with which it is associated; and he says that "the conversion of vegetable substances into coal has been effected by the agency of water;" and also that coal has been formed, not from dwarfish mosses, sedges, and other plants which now contribute to the growth of our peat-bogs, but from the stems and trunks of the forest trees of the Carboniferous Period, such as *Sigillariæ*, *Lepdodendra*, and *Coniferæ*.* All we know of these plants teaches us that they could not grow in a merely vegetable soil containing but 2 or 3 per cent of mineral matter. Such must have been their soil for hundreds of generations in order to give a depth sufficient for the formation of the South Staffordshire ten-yard seam.

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* Hull, "On the Coal-fields of Great Britain."

All these and other difficulties that have stood so long in the way of a satisfactory explanation of the origin of coal appear to me to be removed if we suppose that during the Carboniferous Period Britain and other coal-bearing countries had a configuration similar to that which now exists in Norway, viz., inland valleys terminating in marine estuaries, together which inland lake basins. If to this we superadd the warm and humid climate usually attributed to the Carboniferous Period, on the testimony of its vegetable fossils, all the conditions requisite for producing the characteristic deposits of the Coal Measures are fulfilled.

We have first the under-clay due to the beginning of this state of things, during which the hill slopes were slowly acquiring the first germs of subsequent forest life, and were nursing them in their scanty youth. This deposit would be a mineral mud with a few fossils and that fragmentary or fine deposit of vegetable matter that darkens the carboniferous shales and strips the sandstones. Such a bed of dark cousolidated mud, or fine clay, is found under every seam of coal, and constitutes the "floor" of the coal pit. The characteristic striped rocks—the "linstey" or "linsey" of the Welsh colliers—is just such as I found in the course of formation in the Aachensee near the shore, as described above.

The prevalence of estuarine and lacustrine fossils in the Coal Measures is also in accordance with this: the constitution of coal-ash is perfectly so. Its extreme softness and fineness of structure; its chemical resemblance to the rocks around, and above, and below; and oblong basin form common to our coal seams; the apparent contradiction of such total destruction of vegetable structure common to the true coal seams, while immediately above and below them are delicate structures well preserved, is explained by the more rapid deposition of the latter, and the slow soddening of the former as above described.

I do not, however, offer this as an explanation of the formation of *every kind of coal.* On the contrary, I am satisfied that cannel coal, and the black shales usually associated with it, have a different origin from that of the ordinary varieties of bituminous coal. The fact that the products of distillation of cannel and these shales form different series of hydrocarbons from those of common coal, and that they are nearly identical with those obtained by the distillation of peat, is suggestive of origin in peat-bogs, or something analogous to them.

To the above I may add the concluding sentences of the chapter on Coal in Lyell's "Elements of Geology." Speaking of fossils in the Coal Measures, he says: "The rarity of air-breathers is a very remarkable fact when we reflect that our opportunities of examining strata *in close connection with ancient land* exceed in this case all that we enjoy in regard to any other formations, whether primary, secondary, or tertiary. We have ransacked hundreds of soils replete with the fossil roots of trees, have dug out hundreds of erect trunks and stumps which stood in the position in which they grew, have broken up myriads of cubic feet of fuel still retaining its vegetable structure, and, after all, we continue almost as much in the dark respecting the invertebrate air-breathers of this epoch, *as if the coal had been thrown down in mid-ocean.* The early date of the carboniferous strata cannot explain the enigma, because we know that while the land supported a luxuriant vegetation, the contemporaneous seas swarmed with life—with Articulata, Mollusca, Radiata, and Fishes. We must, therefore, collect more facts if we expect to solve a problem which, in the present state of science, cannot but excite our wonder; and we must remember how much the conditions of this problem have varied within the last twenty years. We must be content to impute the scantiness of our data and our present perplexity partly to our want of diligence as collectors, and partly to our want of skill as interpreters. We must also confess that our ignorance is great of the laws which govern the fossilization of land animals, whether of low or high degree."

The explanation of the origin of coal which I have given in the foregoing meets all these difficulties. It shows how vast accumulations of vegetable matter may have been formed "in close connection with the ancient land," and yet "as if the coal had been thrown down in mid-ocean" as far as the remains of terrestrial animals are concerned. It explains the nearly total absence of land shells, and of the remains of other animals that must have lived in the forests producing the coal, and which would have been buried there with the coal had it been formed on land as usually supposed. It also meets the cases of the rare and curious exceptions, seeing that occasionally a land animal would here and there be drowned in such fjords under cirumstances favorable to its fossilization.

THE SOLAR ECLIPSE OF 1871.

THE FIRST TELEGRAMS.

THIS time we may fairly expect some approach to a solution of the riddle of the corona, as the one essential which neither scientific skill nor Government liberality could secure to the eclipse observers, has been afforded, viz., fine weather. The telegraph has already informed us of this, and also that good use has been made of the good weather. From one station we are told: "Thin mist; spectroscope satisfactory; reversion of lines entirely confirmed; six good photographs." From another: "Weather fine; telescopic and camera photographs successful; ditto polarization; good sketches; many bright lines in spectrum."

This is very different from the gloomy accounts of the expedition of last year; when we consider that the different observers are far apart, and that if all or some of them are similarly favored we shall have in the photographs a series of successive pictures taken at intervals of time sufficiently distant to reveal any progressive changes that may have occurred in the corona while the moon's shadow was passing from one station to the other. I anticipate some curious revelations from these progressive photographs, that may possibly reconcile the wide differences in the descriptions that competent observers have given of the corona of former eclipses, which they had seen at stations distant from each other.

Barely two years have elapsed since I suggested, in "The Fuel of the Sun," that the great solar prominences and the corona are due to violent explosions of the dissociated elements of water; that the prominences are the gaseous flashes, and the corona the ejected scoria, or solidified metallic matter belched forth by the furious cannonade continually in progress over the greater portion of the solar surface.

This explanation at first appeared extravagant, especially as it was carried so far as to suggest that not merely the corona, but the zodiacal light, the zone of meteors which occasionally drop showers of solid matter upon the earth, and even the "pocket-planets" or asteroids so irregularly scattered between the orbits of Mars and Jupiter, consist of solid matter thus ejected by the great solar eruptions. Even up to the spring of the present year, when Mr. Lockyer and other leaders of the last year's expeditions reported their imperfect results, and compared them with various theories, this one was not thought worthy of their attention.

Since that time—during the past six or eight months—a change has taken place which strikingly illustrates the rapid progress of solar discovery. Observations and calculations of the force and velocity of particular solar eruptions have been made, and the results have proved that they are amply sufficient to eject solid missiles even further than I supposed them to be carried.

Mr. Proctor, basing his calculations upon the observations of Respighi, Zöllner, and Professor Young, has concluded that it is even possible that meteoric matter may be ejected far beyond the limits of our solar system into the domain of the gravitation of other stars, and that other stars may in like manner bombard the sun.

This appears rather startling; but, as I have already said, the imagination of the poet and the novelist is beggared by the facts revealed by the microscope, so I may now repeat the assertion, and state it still more strongly, in reference to the revelations of the telescope and the spectroscope.

As a sample of these, I take the observations of Professor Young, made on September 7th last, and described fully in "Nature" on October 19.

He first observed a number of the usual flame-prominences having the typical form which has been compared to a "banyan grove." One of these banyans was greater than the rest. This monarch of the solar flame-forest measured *fifty-four thousand miles in height*, and its outspreading measured in one direction about *one hundred thousand miles.* It was a large eruption-flame, but others much larger have been observed, and Professor Young would probably have merely noted it among the rest, had not something further occurred. He was called away for twenty-five minutes, and when he returned "the whole thing had been literally blown to shreds by some inconceivable uprush from beneath." The space around "was filled with flying *débris*—a mass of detached vertical fusiform filaments, each from 10 sec. to 30 sec. long by 2 sec. or 3 sec. wide, brighter and closer together where the pillars had formerly stood, *and rapidly ascending.*" Professor Young goes on to say, that "When I first looked, some of them had already reached a height of 100,000 miles, and while I watched they rose, with a motion almost perceptible to the eye, until in ten minutes the uppermost were 200,000 miles above the solar surface. This was ascertained by careful measurement."

Here, then, we have an observed velocity of 10,000 miles per minute, and this is the gaseous matter, merely the flash of the gun by which the particles of solidified solar matter are supposed to be projected.

The reader must pause and reflect, in order to form an adequate conception of the magnitudes here treated—100,000 miles long and 54,000 miles high! What does this mean? Twelve and a half of our worlds placed side by side to measure the length, and six and three quarters, piled upon each other, to measure the height! A few hundred worlds as large as ours would be required to fill up the whole cubic contents of this flame-cloud. The spectroscope has shown that these prominences are incandescent hydrogen. Most of my readers have probably seen a soap-bubble or a bladder filled with the separated elements of water, and then exploded, and have felt the ringing in their ears that has followed the violent detonation.

Let them struggle with the conception of such a bubble or bladder magnified to the dimensions of only one such a world as ours, and then exploded; let them strain their power of imagination even to the splitting point, and still they must fail most pitifully to picture the magnitude of this solar explosion observed on September 7th last, which flashed out to a magnitude of more than five hundred worlds, and then expanded to the size of more than five thousand worlds, even while Professor Young was watching it. Professor Young concludes his description by stating that "it seems far from impossible that the mysterious coronal streamers, if they turn out to be truly solar, as now seems likely, may find their origin and explanation in such events."

This, and a number of similar admissions, suggestions, and conclusions from the leading astronomers, indicate that the eruption theory of the corona will not be passed over in silence by the observers of this eclipse, and it is to this that I have referred in the above remarks respecting the interest attaching to a series of photographs showing successive states of this outspreading enigma.

Father Secchi's spectroscopic observations on the uneclipsed sun led him to assert the existence of a stratum of glowing metallic vapors immediately below the envelope connected with the hydrogen of the eruptions. This is just what is required by my eruption theory to supply the solid materials of the ejections forming the corona.

Professor Young's announcement of the reversal of the spectroscopic lines at the moment when the stratum was seen independently of the general solar glare, startled Mr. Lockyer and others who had disputed the accuracy of the observations of the great Italian observer, as it confirmed them so completely. Scepticism still prevailed, and Young's observation was questioned; but now even our slender telegraphic communication from Colonel Tenant to Dr. Huggins indicates that the question must be no longer contested. "Reversion of lines entirely confirmed" is a message so important that if the expeditions had done no more than this, all their cost in money and scientific labor would be amply repaid in the estimation of those who understand the value of pure truth.

A few more fragments of intelligence respecting the Eclipse Expedition have reached us, the last Indian mail having started just after the eclipse occurred. They fully confirm the first telegraphic announcement, rather strengthening than otherwise the expectations of important results, especially in reference to the photographs of the corona.

I have read in the Ceylon newspapers some full descriptions by amateur observers, in which the general magnificence of the phenomena is described. From these it is evident that the corona must have been displayed in its full grandeur; but as the writers do not attempt to describe those features which have at the present moment a special scientific interest, I shall not dwell upon them, but await the publication of the official report of the chief, and of the more important collateral observing expeditions.

The unsophisticated reader may say "Are not one man's eyes as good as another's, and why should the observations of the learned men of the expeditions be so much better than those of any other clear-sighted persons?" This is a perfectly fair question, and admits of a ready answer. All that can be known by mere unprepared naked-eye observation is tolerably well known already; the questions which await solution can only be answered by putting the sun to torture by means of instruments specially devised for that purpose; and by a skillful organization, and division of labor among the observers.

There is so much to be seen during the few seconds of total obscuration that no one human being, however well trained in the art of observing, could possibly see all. Therefore it is necessary to pre-arrange each observer's part, to have careful rehearsals of what is to be done by each during the precious seconds; and each man must exercise a vast amount of self-control in order to confine his attention to his own particular bit of observation, while he is surrounded with such marvellous phenomena as a total eclipse presents.

The grandeur of the gloomy landscape, the sudden starting out of the greater stars, the seeming falling of the vault of heaven, the silence of the animal world, the closing of the flowers, and all that the ordinary observer would regard with so much awe and wondering delight, must be sacrificed by the philosopher, whose business is to confine his gaze to a narrow slit between two strips of metal, and to watch nothing else but the exact position and appearance of a few bright or dark lines across what appears but a strip of colored riband. He must resist the temptation to look aside and around with the stubbornness of self-denial of another St. Antonio. Besides this, he must thoroughly understand exactly what to look for, and how to find it. By combining the results of his observations with those of the others, who in like manner have undertaken to work with another instrument, or upon another part of the phenomena, we get a scientific result comparable to that which in a manufactory we obtain by the division of labor of many skilled workmen, each doing only that which by his training he has learned to do the best and the most expeditiously.

Further Details by Post.

Although the formal official reports of the Eclipse Expedition are not yet published, and may not be for some weeks or months, we are able from the letters of Lockyer, Jannsen, Respighi, Maclear, etc., to form some idea of the general results. We may already regard two or three important questions as fairly answered. The reversal of the dark solar lines of the spectrum which was first announced by the great Roman observer, Father Secchi, and seen by him without an eclipse, may now be considered as established. It is true that all the observers of 1871 did not witness this. Some were doubtful, but others observed it positively and distinctly.

In such a case negative results do not refute the positive observations of qualified men, especially when several of such observations have been made independently; the phenomenon is but instantaneous, a mere flash of bright stripes in place of dark lines across the colored riband of the spectroscope, which happens just at the moment before and after totality, and is presented only when the instrument is accurately directed to the delicate curved vanishing thread of light which is the last visible fragment of the solar outline, and that which makes the first flash of his re-appearance.

A little explanation is necessary to render the significance of this "reversal" intelligible to those who have not specially studied the subject.

1st. When the spectroscope is directed to a luminous solid a simple rainbow-band or "continous spectrum" is seen. When, on the other hand, the object is a luminous gas or vapor of moderate density, the spectrum is not a continuous band with its colors actually blending; it consists only of certain luminous stripes with blank spaces between them, each particular gas or vapor showing its own particular set of stripes of certain colors, and always appearing at exactly the same place, so invariably and certainly, that, by means of such luminous stripes, the composition of the gas or vapor may be determined. If, however, the gas be much compressed, the stripes widen as the condensation proceeds; they may even spread out sufficiently to meet and form a continuous spectrum like that from a solid. Liquids also produce continuous spectra.

2d. When a luminous solid or liquid, or very dense gas, capable of producing a continuous spectrum, is viewed through an intervening body of other gas or vapor of moderate or small density, fine *dark lines* cross the spectrum in precisely the same places as the bright stripes would appear if this intervening gas or vapor were luminous and seen by itself.

When the spectroscope is directed to the face of the sun under ordinary circumstances, it presents a brilliant continuous spectrum, striped with a multitude of the dark lines. From this it has been inferred that the luminous face of the sun is that of an incandescent solid or liquid, and that it is surrounded by the gases and vapors whose bright stripes, when artificially produced, occupy precisely the same places as the dark lines of the solar spectrum. This was the theory of Kirchoff and others in the early days of spectrum analysis, when it was only known that solids and liquids were capable of producing a continuous spectrum. The important discovery that gases and vapors, if sufficiently condensed, will also produce a continuous spectrum, opened another speculation, far more consistent with the other known facts concerning the constitution of the sun, viz., that the sun may be a great gaseous orb, blazing at its surface and gradually increasing in density from the surface towards the centre.

According to this, the metals sodium, calcium, barium, magnesium, iron, chromium, nickel, copper, zinc, strontium, cobalt, manganese, aluminium, and titanium, whose vapors, with those of some few other substances, give the dark lines that cross the solar spectrum, should exist neither as solids nor liquids on the solar surface, but as blazing gases. But such blazing gases, according to what I have stated above, should give us bright stripes instead of dark lines. Why, then, are not such bright stripes seen under ordinary circumstances?

This is easily answered. These blazing gases must, as we proceed from the surface of the sun downwards, become so condensed by the pressure of their own superincumbent strata, as to produce a continuous spectrum of great brilliancy. With such a background the bright stripes would be confounded and lost to sight. Besides this, the outer film of cooler vapor through which our vision must necessarily penetrate before reaching the luminous solar surface, will produce the dark lines exactly where the bright stripes should be, and thus effectually obliterate them ; or, in other words, the intervening non-luminous vapors are opaque to the particular rays of light which the bright vapors of the same substance emits.

Therefore, according to this theory, if we could sweep away these outside darkening vapors, and screen off the inner layers of denser blazing matter which produces the continuous background, we should have a spectrum displaying a multitude of bright stripes exactly where the black lines of the ordinary solar spectrum appear.

Secchi announced that these bright lines were to be seen under favorable circumstances, when, by skillful management, the rays from the edge of the sun were so caught by the slit of the spectroscope as to exhibit only the spectrum of the superficial layer of the sun's bright surface. This was disputed at the time by Mr. Lockyer, who, I suspect, omitted to consider the atmospheric difficulties under which English astronomers work, and the fact that the atmosphere of Italy is exceptionally favorable for delicate astronomical observation.

If he had fairly considered this I think he would agree with me in concluding that an observation of this kind, avowedly made with great difficulty and questionable distinctness by so skillful a spectroscopic observer as Father Secchi, could not possibly be seen by any human eyes through a London atmosphere.

Subsequently Professor Young startled the astronomical world by the announcement that, at the moment when the thinnest perceptible thread of the sun's edge was alone displayed during the eclipse which he observed, the whole of the dark lines of the solar spectrum flashed out as bright stripes in a most unmistakable manner. This observation is now fully confirmed. The first telegrams from Mr. Pogson, the Government astronomer of Madras, and from Colonel Tennant, both announce this most positively, Colonel Tennant's words being, "the reversion of the lines fully confirmed." A similar result was obtained by some, but not by all, of the Ceylon observers.

To understand this clearly, we must consider the fact that what appears to us as the outline of a flat disc is really that part of the sun which we see by looking horizontally athwart his rotundity, just as we look at the ocean surface of our own earth when we stand upon the shore and see its horizon outline. When the moon obscures all but the last film of this solar edge, we see only the surface of the supposed gaseous orb, just that portion of the blazing gases which are not greatly compressed by those above them, and which accordingly should, if they consist of the vapors or the gases above named, display a bright-striped spectrum, provided the intervening non-luminous vapors of the same metals are not sufficiently abundant to obscure them—at this particular moment, when only the absolute horizon-line is seen, and the body of the moon cuts off all the intervening solar surface, and the lower or denser portion of the intervening super-solar vapors, though, of course, these are not so entirely cut off as the continuous background.

The reversion of the dark lines therefore reveals to us the stupendous fact that the surface of the mighty sun, which is as big as a million and a quarter of our worlds, consists of a flaming ocean of hydrogen and of the metals above-named in a gaseous condition, similar to that of the hydrogen itself.

This fact, coupled with the other revelations of the spectroscope, which, without the help of an eclipse, reveals the surface outline of the sun, the "sierra" and the "prominences" tell us that this flaming ocean is in a state of perpetual tempest, heaving up its billows and flame-Alps hundreds and thousands of miles in height, and belching forth above all these still taller pillars of fire that even reach an elevation of more than a hundred thousand miles, and then burst out into mighty clouds of flame and vapor, bigger than five hundred worlds.

What does the last eclipse teach us in reference to the corona? Firstly and clearly, that Lockyer's explanation which attributed it to an illumination of the upper regions of the earth's atmosphere must be now for ever abandoned. This theory has died hard, but, in spite of Mr. Lockyer's proclamation of "victory all along the line," it is now past galvanizing. There can be no further hesitation in pronouncing that the corona actually belongs to the sun itself, that it is a marvelous solar appendage extending from the sun in all directions, but by no means regularly.

The immensity of this appendage will be best understood by the fact that the space included within the outer limits of the visible corona is at least twenty times as great as the bulk of the sun itself, that above twenty-five millions of our worlds would be required to fill it.

Jannsen says: "I believe the question whether the corona is due to the terrestrial atmosphere is settled, and we have before us the prospect of the study of the extra-solar regions, which will be very interesting and fertile."

The spectroscope, the polariscope, and ordinary vision all concur in supporting the explanation that the corona is composed of solid particles and gaseous matter intermingled. It fulfils exactly all the requirements of the hypothesis which attributes it to the same materials as those which in a gaseous state cause the reversion of the dark lines above described, but which have been ejected with the great eruptions forming the solar prominences, and have become condensed into glowing metallic hailstones as their distance from the central heat has increased. These must necessarily be accompanied by the vapors of the more volatile materials, and should give out some of the lighter gases, such as hydrogen, which, under greater pressure, would be occluded within them, just as the hydrogen gas occluded within the substance of the Lenarto meteor (a mass of iron which fell from the sky upon the earth) was extracted by the late Master of the Mint by means of his mercurial air-pump.

The rifts or gaps between the radial streamers, which have been so often described and figured, but were regarded by some as optical illusions, are now established as unquestionable facts. Mr. Lockyer, the last to be convinced, is now compelled to admit this, which overthrows the supposition that this solar appendage is a luminous solar atmosphere of any kind. If it were gaseous or true vapor, it must obey the law of gaseous diffusion, and could not present the phenomena of bright radial streamers, with dark spaces between them, unless it were in the course of very rapid radial motion either to or from the sun.

The photographs have not yet been published. When they have all arrived, and can be compared, we shall learn something that I anticipate will be extremely interesting respecting the changes of the corona, as they have been taken at the different stations at different times. I alluded to this subject before, when it was only a matter of possibility that such a succession of pictures might have been taken. We now have the assurance that such pictures have been obtained. There can be no question about optical illusion in these; they are original affidavits made by the corona itself, signed, sealed, and delivered as its own act and deed.

METEORIC ASTRONOMY.

THE number of the *Quarterly Journal of Science* for May, 1872, contains some articles of considerable interest. The first is by the indefatigable Mr. Proctor, on "Meteoric Astronomy," in which he embodies a clear and popular summary of the researches which have earned for Signor Schiaparelli this year's gold medal of the Astronomical Society. Like all who venture upon a broad, bold effort of scientific thought, extending at all into the regions of philosophical theory, Schiaparelli has had to wait for recognition. A simple and merely mechanical observation of a bare fact, barely and mechanically recorded without the exercise of any other of the intellectual faculties than the external senses and observing powers, is at once received and duly honored by the scientific world; but any higher effort is received at first indifferently, or sceptically, and is only accepted after a period of probation, directly proportionate to its philosophical magnitude and importance, and inversely proportionate to the scientific status of the daring theorist.

At first sight this appears unjust, it looks like honoring the laborers who merely make the bricks, and despising the architect who constructs the edifice of philosophy from the materials they provide. Many a disappointed dreamer, finding that his theory of the universe has not been accepted, and that the expected honors have not been showered upon him, has violently attacked the whole scientific community as a contemptible gang of low-minded mechanical plodders, void of imagination, blind to all poetic aspirations, and incapable of any grand and comprehensive flight of intellect.

Had these impulsive gentlemen been previously subjected to the strict discipline of inductive scientific training, their position and opinions would have been very different. Their great theories would either have had no existence, or have been much smaller, and they would understand that philosophic caution is one of the characteristic results of scientific training.

Simple facts, which can be immediately proved by simple experiments and simple observations, are at once accepted, and their discoverers duly honored, without any hesitation or delay, but the grander efforts of generalization require careful thought and laborious scrutiny for their verification, and therefore the acknowledgment of their merits is necessarily delayed; but when it does arrive full justice is usually done.

Thus Grove's "Correlation of the Physical Forces," the greatest philosophical work on purely physical science of this generation, was commenced in 1842, when its author occupied but a humble position at the London Institution. The book was but little noticed for many years, and, had Mr. Grove (now Sir William Grove) not been duly educated by the discipline above referred to, he might have become a noisy cantankerous martyr, one of those "ill-used men" who have been made familiar to so many audiences by Mr. George Dawson.

Instead of this, he patiently waited, and, as we have lately seen, the well-deserved honors have now been liberally awarded.

In a very few years hence we shall be able to say the same of the once diabolical Darwin, and eight or nine other theorists, who must all be content to take their trial and patiently await the verdict; the time of waiting being of necessity proportionate to the magnitude of the issue.

The theories of Schiaparelli, which, as Mr. Proctor says, "after the usual term of doubt have so recently received the sanction of the highest astronomical tribunal of Great Britain," are not of so purely speculative a character as to demand a very long "term of doubt." They are directly based on observations and mathematical calculations which bring them under the domain of the recognized logic of mathematical probability. Those who are specially interested in the modern progress of astronomy should read this article in the *Quarterly Journal of Science*, which is illustrated with the diagrams necessary for the comprehension of the researches and reasoning of Schiaparelli and others who have worked on the same ground.

I can only state the general results, which are that the meteors which we see every year, more or less abundantly, on the nights of the 10th and 11th of August, and which always appear to come from the same point in the heavens, are then and thus visible because they form part of an eccentric elliptical zone of meteoric bodies which girdle the domain of the sun; and that our earth, in the course of its annual journey around the sun, crosses and plunges more or less deeply into this ellipse of small attendant bodies, which are supposed to be moving in regulur orbits around the sun.

Schiaparelli has compared the position, the direction, and the velocity of motion of the August meteors with the orbit of the great comet of 1862, and infers that there is a close connection between them, so close that the meteors may be regarded as a sort of trail which the comet has left behind. He does not exactly say that they are detached vertebræ of the comet's tail, but suggests the possibility of their original connection with its head.

Similar observations have been made upon the November meteoric showers, which by similar reasoning, are associated with another comet; and further yet, it is assumed upon analogy that other recognized meteor systems, amounting to nearly two hundred in number, are in like manner associated with other comets.

If these theories are sound, our diagrams and mental pictures of the solar system must be materially modified. Besides the central sun, the eight planets and the asteroids moving in their nearly circular orbits, and some eccentric comets traveling in long ellipses, we must add a countless multitude of small bodies clustered in elliptical rings, all traveling together in the path marked by their containing girdle, and following the lead of a streaming vaporous monster, their parent comet.

We must count such comets, and such rings filled with attendant fragments, not merely by tens or hundreds, but by thousands and tens of thousands, even by millions; the path of the earth being but a thread in space, and yet a hundred or two are strung upon it.

In this article Mr. Proctor seems strongly disposed to return to the theory which attributes solar heat and light to a bombardment of meteors from without, and the solar corona and zodiacal light as visible presentments of these meteors. Still, however, he clings to the more recent explanation which regards the corona, the zodiacal light, and the meteors as matter ejected from the sun by the same forces as those producing the solar prominences. For my own part I shall not be at all surprised if we find that, ere long, these two apparently conflicting hypotheses are fully reconciled.

The progress of solar discovery has been so great since January, 1870, when my ejection theory was published, that I may now carry it out much further than I then dared, or was justified in daring to venture. Actual measurement of the projectile forces displayed in some of the larger prominences renders it not merely possible, but even very probable, that some of the exceptionally great eruptive efforts of the sun may be sufficiently powerful to eject solar material beyond the reclaiming reach of his own gravitating power.

In such a case the banished matter must go on wandering through the boundless profundity of space until it reaches the domain of some other sun, which will clutch the fragment with its gravitating energies, and turn its straight and ever onward course into the curved orbit. Thus the truant morsel from our sun will become the subject of another sun—a portion of another solar system.

What one sun may do, another and every other may do likewise, and, if so, there must be a mutual bombardment, a ceaseless interchange of matter between the countless suns of the universe. This is a startling view of our cosmical relations, but we are driving rapidly towards a general recognition of it.

The November star showers have perpetrated some irregularities this year. They have been very unpunctual, and have not come from their right place. We have heard something from Italy, but not the tidings of the Leonides that were expected. Instead of the great display of the month occurring on the 13th and 14th, it was seen on the 27th. We have accounts from different parts of England, Ireland, Scotland, and Wales, also from Italy, Greece, Egypt, etc.

Mr. Slinto, in a letter to the *Times*, estimates the number seen at Suez as reaching at least 30,000, while in Italy and Athens about 200 per minute were observed. They were not, however, the Leonides, that is, they did not radiate from a point in the constellation Leo, but from the region of Andromeda. Therefore they were distinct from that system of small wanderers usually designated the "November meteors," were not connected with Tempel's comet (comet 1, 1866), but belong to quite another set.

The question now discussed by astronomers is whether they are connected with any other comet, and, if so, with which comet?

In the "Monthly Notices" of the Royal Astronomical Society, published October 24th last, is a very interesting paper by Professor Herschel, on "Observations of Meteor Showers," supposed to be connected with "Biela's comet," in which he recommends that "a watch should be kept during the last week in November and the first week in December," in order to verify "the ingenious suggestions of Dr. Weiss," which, popularly stated, amount to this, viz., that a meteoric cloud is revolving in the same orbit as Biela's comet, and that in 1772 the earth dashed through this meteoric orbit on December 10th. In 1826 it did the same, on December 4th; in 1852 the earth passed through the node on November 28th, and there are reasons for expecting a repetition at about the same date in 1872.

The magnificent display of the 27th has afforded an important verification of these anticipations, which become especially interesting in connection with the curious history of Biela's comet, which receives its name from M. Biela, of Josephstadt, who observed it in 1826, calculated its orbit, and considered it identical with the comets of

1772, 1805, etc. It travels in a long eccentric ellipse, and completes its orbit in 2410 days—about 6¾ years. It appeared again, as predicted, in 1832 and 1846.

Its orbit very nearly intersects that of the earth, and thus affords a remote possibility of that sort of collision which has excited so much terror in the minds of many people, but which an enthusiastic astronomer of the present generation would anticipate with something like the sensational interest which stirs the soul of a London street-boy when he is madly struggling to keep pace with a fire-engine.

The calculations for 1832 showed that this comet should cross the earth's orbit a little before the time of the earth's arrival at the same place; but as such a comet, traveling in such an orbit, is liable to possible retardations, the calculations could only be approximately accurate, and thus the sensational astronomer was not altogether without hope. This time, however, he was disappointed ; the comet was punctual, and crossed the critical node about a month before the earth reached it.

As though to compensate for this disappointment, the comet at its next appearance exhibited some entirely new phenomena. It split itself into two comets, in such a manner that the performance was visible to the telescopic observer. Both of these comets had nuclei and short tails, and they alternately varied in brightness, sometimes one, then the other, having the advantage. They traveled on at a distance of about 156,000 miles from each other, with parallel tails, and with a sort of friendly communication in the form of a faint arc of light, which extended as a kind of bridge, from one to the other. Besides this, the one which was first the brighter, then the fainter, and finally the brighter again, threw out two additional tails, one of which extended lovingly towards its companion.

The time of return in 1852 was of course anxiously expected by astronomers, and careful watch was kept for the wanderers. They came again at the calculated time, still separated as before.

They were again due in 1859, in 1866, and, finally, at about the end of last November, or the beginning of the present month. Though eagerly looked for by astronomers in all parts of the civilized world, they have been seen no more since 1852.

What, then, has become of them? Have they further subdivided? Have they crumbled into meteoric dust? Have they blazed or boiled into thin air? or have they been dragged by some interfering gravitation into another orbit? The last supposition is the most improbable, as none of the visible inhabitants of space have come near enough to disturb them.

The possibility of a dissolution into smaller fragments is suggested by the fact that, instead of the original single comet, or the two fragments, meteoric showers have fallen towards the earth at the time when it has crossed the orbit of the original comet, and these showers have radiated from that part of the heavens in which the comet should have appeared. Such was the case with the magnificent display of November 27th, and astronomers are inclining more and more to the idea that comets and meteors have a common origin—the meteors are little comets, or comets are big meteors.

In the latest of the "Monthly Notices," of the Royal Astronomical Society, published last week, is a paper by Mr. Proctor, in which he expands the theory expounded three years ago by an author whom your correspondent's modesty prevents him from naming, viz., that the larger planets—Jupiter, Saturn, Uranus, and Neptune—are minor suns, ejecting meteoric matter from them by the operation of forces similar to those producing the solar promincences.

Mr. Proctor subjects this bold hypothesis to mathematical examination, and finds that the orbit of Tempel's comet and its companion meteors correspond to that which would result from such an eruption occurring on the planet Uranus. An eruptive force effecting a velocity of about thirteen miles per second, which is vastly smaller than the actually measured velocity of the matter of the solar eruptions, would be sufficient to thrust such meteoric or cometary matter beyond the reclaiming reach of the gravitation of Uranus, and hand it over to the sun, to make just such an orbit as that of Tempel's comet and the Leonides meteors.

He shows that other comets and meteoric zones are similarly allied to other planets, and thus it may be that the falling stars and comets are fragments of Jupiter, Saturn, Uranus, or Neptune. Verily, if an astronomer of the last generation were to start up among us now, he would be astounded at modern presumption.

The star shower of November 27th, and its connection with Biela's broken and lost comet, referred to in my last letter, are still subjects of research and speculation. On November 30th Professor Klinkerfues sent to Mr. Pogson, of the Madras Observatory, the following startling telegram: "Biela touched earth on 27th. Search near Theta Centauri."

Mr. Pogson searched accordingly from comet-rise to sunrise on the two following mornings, but in vain; for even in India they have had cloudy weather of late. On the third day, however, he had "better luck," saw something like a comet through an opening between clouds, and on the following days was enabled to deliberately verify this observation and determine the position and some elements of the motion of the comet, which displayed a bright nucleus, and faint but distinct tail.

This discovery is rather remarkable in connection with the theoretical anticipation of Professor Klinkerfues; but the conclusion directly suggested is by no means admitted by astronomers. Some have supposed that it is not the primary Biela, but the secondary comet, or offshoot, which grazed the earth, and was seen by Mr. Pogson; others that it was neither the body, the envelope, nor the tail of either of the comets which formed the star shower, but that the meteors of November 27th were merely a trail which the comet left behind.

A multitude of letters were read at the last and previous meeting of the Astronomical Society, in which the writers described the details of their own observations. As these letters came from nearly all parts of the world, the data have an unusual degree of completeness, and show very strikingly the value of the work of amateur astronomical observers.

By the collation and comparison of these, important inductions are obtainable. Thus Professor A. S. Herschel concludes that the earth passed through seven strata of meteoric bodies, having each a thickness of about 50,000 miles—in all about 350,000 miles. As the diameter of the visible nebulosity of Biela's comet was but 40,000 miles when nearest the earth in 1832, the great thickness of these strata indicates something beyond the comet itself.

Besides this, Mr. Hind's calculation for the return of the primary comet shows that on November 27th it was 250 millions of miles from the earth.

Those, however, who are determined to enjoy the sensation of supposing that they really have been brushed by the tail of a comet, still have the secondary comet to fall back upon. This, as already described, was broken off the original, from which it was seen gradually to diverge, but was still linked to it by an arch of nebulous matter.

If this divergence has continued, it must now be far distant—sufficiently far to afford me an opportunity of safely adding another to the numerous speculations, viz., that we may, on November 27th, have plunged obliquely through this connecting arm of nebulous matter, which was seen stretching between the parent comet and its offshoot. The actual position of the meteoric strata above referred to is quite consistent with the hypothesis.

THE "GREAT ICE AGE" AND THE ORIGIN OF THE "TILL."

The growth of science is becoming so overwhelming that the old subdivisions of human knowledge are no longer sufficient for the purpose of dividing the labor of experts. It is scarcely possible now for any man to become a naturalist, a chemist, or a physicist in the full sense of either term; he must, if he aims at thoroughness, be satisfied with a general knowledge of the great body of science, and a special and a full acquaintance with only one or two of its minor subdivisions. Thus geology, though but a branch of natural history, and the youngest of its branches, has now become so extensive that its ablest votaries are compelled to devote their best efforts to the study of sections which but a few years ago were scarcely definable.

Glaciation is one of these, which now demands its own elementary text-books over and above the monographs of original investigators. This demand has been well supplied by Mr. James Geikie in the "The Great Ice Age,"* of which a second edition has just been issued. Every student of glacial phenomena owes to Mr. Geikie a heavy debt of gratitude for the invaluable collection of facts and philosophy which this work presents. It may now be fairly described as a standard treatise on the subject which it treats.

One leading feature of the work offers a very aggressive invitation to criticism. Scotchmen are commonly accused of looking upon the whole universe through Scotch spectacles, and here we have a Scotchman treating a subject which affects nearly the whole of the globe, and devoting about half of his book to the details of Scottish glacial deposits; while England has but one-third of the space allowed to Scotland, Ireland but a thirtieth, Scandinavia less than a tenth, North America a sixth, and so on with the rest of the world. Disproportionate as this may appear at first glance, further acquaintance with the work justifies the pre-eminence which Mr. Geikie gives to the Scotch glacial deposits. Excepting Norway, there is no country in Europe which affords so fine a field for the study of the vestiges of extinct glaciers as Scotland, and Scotland has an advantage even over Norway in being much better known in geological detail. Besides this, we must always permit the expounder of any subject to select his own typical illustrations, and welcome his ability to find them in a region which he himself has directly explored.

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* "The Great Ice Age, and its Relation to the Antiquity of Man." By James Geikie, F.R.S., etc. Second edition, revised, 1877. Daldy and Isbister.

Mr. Geikie's connection with the geological survey of Scotland has afforded him special facilities for making good use of Scottish typical material, and he has turned these opportunities to such excellent account that no student after reading "The Great Ice Age" will find fault with its decided nationality.

The leading feature—the basis, in fact—of this work deserves especial notice, as it gives it a peculiar and timely value of its own. This feature is that the subject—as compared with its usual treatment by other leading writers—is turned round and presented, so to speak, bottom upwards. De Saussure, Charpentier, Agassiz, Humboldt, Forbes, Hopkins, Whewell, Stark, Tyndall, etc., have studied the living glaciers, and upon the data thus obtained have identified the work of extinct glaciers. Chronologically speaking, they have proceeded backwards, a method absolutely necessary in the early stages of the inquiry, and which has yielded admirable results. Geikie, in the work before us, proceeds exactly in the opposite order. Availing himself of the means of identifying glacial deposits which the retrogressive method affords, he plunges at once to the lowest and oldest of these deposits, which he presents the most prominently, and then works upwards and onwards to recent glaciation.

The best illustration I can offer of the timely advantage of this reversed treatment is (with due apology for necessary egotism) to state my own case. In 1841, when the "glacial hypothesis," as it was then called, was in its infancy, Professor Jamieson, although very old and nearly at the end of his career, took up the subject with great enthusiasm, and devoted to it a rather disproportionate number of lectures during his course on Natural History. Like many of his pupils, I became infected by his enthusiasm, and went from Edinburgh to Switzerland, where I had the good fortune to find Agassiz and his merry men at the "Hotel des Neufchatelois"—two tents raised upon a magnificent boulder floating on the upper part of the Aar glacier. After a short but very active sojourn there I "did," not without physical danger, many other glaciers in Switzerland and the Tyrol, and afterwards practically studied the subject in Norway, North Wales, and wherever else an opportunity offered, reading in the meantime much of its special literature; but, like many others, confining my reading chiefly to authors who start with living glaciers and describe their doings most prominently. When, however, I read the first edition of Mr. Geikie's "Great Ice Age," immediately after its publication, his mode of presenting the phenomena, bottom upwards, suggested a number of reflections that had never occurred before, leading to other than the usual explanations of many glacial phenomena, and correcting some errors into which I had fallen in searching for the vestiges of ancient glaciers. As these suggestions and corrections may be interesting to others, as they have been to myself, I will here state them in outline.

The most prominent and puzzling reflection or conclusion suggested by reading Mr. Geikie's description of the glacial deposits of Scotland was, that the great bulk of them are quite different from the deposits of existing glaciers. This reminded me of a previous puzzle and disappointment that I had met in Norway, where I had observed such abundance of striation, such universality of polished rocks and rounded mountains, and so many striking examples of perched blocks, with scarcely any decent vestiges of moraines. This was especially the case in Arctic Norway. Coasting from Trondhjem to Hammerfest, winding round glaciated islands, in and out of fjords banked with glaciated rock-slopes, along more than a thousand miles of shore line, displaying the outlets of a thousand ancient glacier valleys, scanning eagerly throughout from sea to summit, landing at several stations, and climbing the most commanding hills, I *saw only one ancient moraine*—that at the Oxfjord station described in "Through Norway with Ladies." *

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* The terminal moraine at the Oxfjord station, which I have already mentioned as the only ancient example of an ordinary moraine that I have seen in Arctic Norway, was, of course, a special object of interest to me. Further observation showed that it does not merely consist of the heap of stones I noticed in 1856, which appears like a disturbed talus cut through and heaped up at its lower part,

But this negative anomaly is not all. The ancient glacial deposits are not only remarkable on account of the absence of the most characteristic of modern glacial deposits, but in consisting mainly of something which is quite different from any of the deposits actually formed by any of the modern glaciers of Switzerland or any other country within the temperate zones.

I have seen nothing either at the foot or the sides of any living Alpine or Scandinavian glacier that even approximately represents the "till" or "boulder clay," nor any description of such a formation by any other observer; and have met with no note of this very suggestive anomaly by any writer on glaciers. Yet the till and bowlder clay form vast deposits, covering thousands of square miles even of the limited area of the British Isles, and constitute the main evidence upon which we base all our theories respecting the existence and the vast extent and influence of the "Great Ice Age."

Although so different from anything at present produced by the Alpine or Scandinavian glaciers, this great deposit is unquestionably of glacial origin. The evidences upon which this general conclusion rests are fully stated by Mr.

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but that there is another moraine adjoining it, or in continuation with it, which is covered with vegetation, and stretches quite across the mouth of the valley. The Duke of Roxburgh, who is well acquainted with this neighborhood, having spent sixteen summers in Arctic Norway, was one of our fellow-passengers, and told me that this moraine forms a barrier that dams up the waters of a considerable lake, abounding with remarkably fine char. I learned this just as the packet was starting, too late to go on shore even for a few minutes, and obtain a view of this lake and the valley beyond. This I regret, as it might have revealed some explanation of the exceptional nature of this moraine. It would be interesting to learn whether it belongs to the greater ice age, or to that period of minor glaciation that fashioned the farm patches already described. The formation of the lake is easily understood in the latter case. It is only required that such a minor reglaciated valley as one of these should be of larger magnitude and of very gentle inclination at its lower part, so that the secondary glacier should die out before reaching the present seashore. It would then deposit its moraine across the mouth of the valley, and this moraine would dam up the waters which such a valley must necessarily receive from the drainage of its hilly sides. Llyn Idwal, in North Wales, is a lake thus formed.

Geikie, and may safely be accepted as incontrovertible. Whence, then, the great difference?

One of the suggestions to which I have already alluded as afforded by reading Mr. Geikie's book was a hypothetical solution of this difficulty, but the verification of the hypothesis demanded a re-visit to Norway. An opportunity for this was afforded in the summer of 1874, during which I traveled round the coast from Stavanger to the Arctic frontier of Russia, and through an interesting inland district. The observations there made and strengthened by subsequent reflections, have so far confirmed my original speculative hypothesis that I now venture to state it briefly as follows:

That the period appropriately designated by Mr. Geikie as the "Great Ice Age" includes at least two distinct periods or epochs—the first of very great intensity or magnitude, during which the Arctic regions of our globe were as completely glaciated as the Antarctic now are, and the British islands and a large portion of Northern Europe were glaciated as completely, and nearly in the same manner, as Greenland is at the present time; that long after this, and immediately preceding the present geological epoch, there was a minor glacial period, when only the now existing valleys, favorably shaped and situated for glacial accumulations, were partially or wholly filled with ice. There may have been many intermediate fluctuations of climate and glaciation, and probably were such, but as these do not affect my present argument they need not be here considered.

So far I agree with the general conclusions of Mr. Geikie as I understand them, and with the generally received hypotheses, but in what follows I have ventured to diverge materially.

It appears to me that the existing Antarctic glaciers and some of the glaciers of Greenland are essentially different in their conformation from the present glaciers of the Alps, and from those now occupying some of the fjelds and valleys of Norway; and that the glaciers of the earlier or greater glacial epoch were similar to those now forming the Antarctic barrier, while the glaciers of the later or minor glacial epoch resembled those now existing in temperate climates, or were intermediate between these and the Antarctic glaciers. The nature of the difference which I suppose to exist between the two classes of glaciers is this: The glaciers (properly so called) of temperate climates are the overflow of the *nevé* (the great reservoir of ice and snow above the snow line). They are composed of ice which is protruded below the snow-line into the region where the summer thaw exceeds the winter snow-fall. This ice is necessarily subject to continual thinning or wasting from its *upper* or exposed surface, and thus finally becomes liquefied, and is terminated by direct solar action.

Many of the characteristic phenomena of Alpine glaciers depend upon this; among the more prominent of which are the superficial extrusion of boulders or rock fragments that have been buried in the *nevé* or have fallen into the crevasses of the upper part of the true glacier, and the final deposit of these same boulders of fragments at the foot of the glaciers forming ordinary moraines.

But this is not all. The thawing which extrudes, and finally deposits the larger fragments of rock, sifts from them the smaller particles, the aggregate bulk of which usually exceeds very largely that of the larger fragments. This fine silt or sand thus washed away is carried by the turbid glacier torrent to considerable distances, and deposited as an alluvium wherever the agitated waters find a resting-place.

Thus the *débris* of the ordinary modern glacier is effectively separated into two or more very distinct deposits; the moraine at the glacier foot consisting of rock fragments of considerable size with very little sand or clay or other fine deposit between them, and a distant deposit of totally different character, consisting of gravel, sand, clay, or mud, according to the length and conditions of its journey. The "chips," as they have been well called, are thus separated from what I may designate the *filings* or *sawdust* of the glacier.

The filings from the existing glaciers of the Bernese Alps are gradually filling up the lake-basins of Geneva and Constance, repairing the breaches made by the erosive action of their gigantic predecessors; those of the southern slope of the Alps are doing a large share in filling up the Adriatic; while the chips of all merely rest upon the glacier beds forming the comparatively insignificant terminal moraine deposits.

The same in Scandinavia. The Storelv of the Jostedal is fed by the melting of the Krondal, Nygaard, Bjornestegs, and soldal glaciers. It has filled up a branch of the deep Sogne fjord, forming an extensive fertile plain at the mouth of its wild valley, and is depositing another subaqueous plain beyond, while the moraines of the glaciers are but inconsiderable and comparatively insignificant heaps of loose boulders, spread out on the present and former shores of the above-named glaciers, which are overflows from one side of the great *nevé*, the Jostedal Sneefond. All of these glaciers flow down small lateral valleys, spread out, and disappear in the main valley, which has now no glacier of its own, though it was formerly glaciated throughout.

What must have been the condition of this and the other great Scandinavian valleys when such was the case? To answer this question rationally we must consider the meteorological conditions of that period. Either the climate must have been much colder, or the amount of precipitation vastly greater than at present, in order to produce the general glaciation that rounded the mountains up to a height of some thousands of feet above the present sea-level. Probably both factors co-operated to effect this vast glaciation, the climate colder, and the snow-fall also greater. The whole of Scandinavia, or as much as then stood above the sea, must have been a *nevé* or sneefond on which the annual snow-fall exceeded the annual thaw.

This is the case at present on the largest *nevé* of Europe, the 500 square miles of the great plateau of the Jostedals and Nordfjords Sneefond, on all the overflowing *nevé* or snow-fields of the Alps above the snow-line; over the greater part of Greenland; and (as the structure of the southern icebergs prove) everywhere within the great Antarctic ice barrier.

What, then, must happen when the snow-line comes down, or nearly down, to the sea-level? It is evident that the out-thrust glaciers, the overflow down the valleys, cannot come to an end like the present Swiss and Scandinavian glaciers, by the direct melting action of the sun. They may be somewhat thinned from below by the heat of the earth, and that generated by their own friction on the rocks, but these must be quite inadequate to overcome the perpetual accumulation due to the snow-fall upon their own surface and the vast overflow from the great snow-fields above. They must go on and on, ever increasing, until they meet some new condition of climate or some other powerful agent of dissipation—something that can effectively melt them.

This agent is very near at hand in the case of the Scandinavian valleys and those of Scotland. It is the sea. I think I may safely say that the valley glaciers of these countries during the great ice age *must* have reached the sea, and there have terminated their existence, just as the Antarctic glaciers terminate at the present Antarctic ice-wall.

What must happen when a glacier is thus thrust out to sea? This question is usually answered by assuming that it slides along the bottom until it reaches such a depth that flotation commences and then it breaks off or "calves" as icebergs. This views is strongly expressed by Mr. Geikie (p. 47) when he says that—"The seaward portion of an Arctic glacier cannot by any possibility be floated up without sundering its connection with the frozen mass behind. So long as the bulk of the glacier much exceeds the depth of the sea, the ice will of course rest upon the bed of the fjord or bay without being subjected to any strain or tension. But when the glacier creeps outwards to greater depths, then the superior specific gravity of the sea-water will tend to press the ice upward. That ice, however, is a hard continuous mass, with sufficient cohesion to oppose for a time this pressure, and hence the glacier crawls on to a depth far beyond the point at which, had it been free, it would have risen to the surface and floated. If at this great depth the whole mass of the glacier could be buoyed up without breaking off, it would certainly go to prove that the ice of Arctic regions, unlike ice anywhere else, had the property of yielding to mechanical strain without rupturing. But the great tension to which it is subjected takes effect in the usual way, and the ice yields, not by bending and stretching, but by breaking." Mr. Geikie illustrates this by a diagram showing the "calving" of an iceberg.

In spite of my respect for Mr. Geikie as a geological authority, I have no hesitation in contradicting some of the physical assumptions included in the above.

Ice has no such rigidity as here stated. It *does* possess in a high degree "the property of yielding to mechanical strain without rupturing." We need not go far for evidence of this. Everybody who has skated or seen others skating on ice that is but just thick enough to "bear" must have felt or seen it yield to the mechanical strain of the skater's weight. Under these conditions it not only bends under him, but it afterwards yields to the reaction of the water below, rising and falling in visible undulations, demonstrating most unequivocally a considerable degree of flexibility. It may be said that in this case the flexibility is due to the thinness of the ice; but this argument is unsound, inasmuch as the manifestation of such flexibility does not depend upon absolute thickness or thinness, but upon the relation of thickness to superficial extension. If a thin sheet of ice can be bent to a given arc, a thick sheet may be bent in the same degree, but the thicker ice demands a greater radius and proportionate extension of circumference. But we have direct evidence that ice of great thickness—actual glaciers—may bend to a considerable curvature before breaking. This is seen very strikingly when the uncrevassed ice-sheet of a slightly inclined *nevé* suddenly reaches a precipice and is thrust over it. If Mr. Geikie were right, the projecting cornice thus formed should stand straight out, and then, when the transverse strain due to the weight of this rigid overhang exceeded the resistance of tenacity, it should break off short, exposing a face at right angles to the general surface of the supported body of ice. Had Mr. Geikie ever seen and carefully observed such an overhang or cornice of ice, I suspect that the above-quoted passage would not have been written.

Some very fine examples of such ice-cornices are well seen from the ridge separating the Handspikjen Fjelde from the head of the Jostedal, where a view of the great *nevé* or sneefond is obtained. This side of the *nevé* terminates in precipitous rock-walls; at the foot of one of these is a dreary lake, the Styggevand. The overflow of the *nevé* here forms great bending sheets that reach a short way down, and then break off and drop as small icebergs into the lake.*

The ordinary course of glaciers affords abundant illustrations of the plasticity of such masses of ice. They spread out where the valley widens, contract where the valley narrows, and follow all the convexities or concavities of the axial line of its bed. If the bending thus enforced exceeds a certain degree of abruptness crevasses are formed, but a considerable bending occurs before the rupture is effected, and crevasses of considerable magnitude are commonly formed without severing one part of a glacier from another. They are usually **V**-shaped, in vertical section, and in many the rupture does not reach the bottom of the glacier. Very rarely indeed does a crevasse cross the whole breadth of a glacier in such a manner as to completely separate, even temporarily, the lower from the upper part of the glacier.

If a glacier can thus bend *downwards* without "sundering its connection with the frozen mass behind," surely it may bend upwards in a corresponding degree, either with or without the formation of crevasses, accoring to the thickness of the ice and the degree of curvature.

A glacier reaching the sea by a very steep incline would probably break off, in accordance with Mr. Geikie's description, just as an Alpine glacier is ruptured fairly across when it makes a cascade over a suddely precipitous bend of its path. One entering the sea at an inclination somewhat less precipitous than the minor limit of the effective rupture gradient would be crevassed in a contrary manner to the crevassing of Alpine glaciers. Its crevasses would gape downwards instead of upwards—have **Λ**-shaped instead of a **V**-shaped section.

With a still more moderate slope, the up-floating of the termination of the glacier, and a concurrent general up-lifting or upbending of the whole of its submerged portion might occur without even a partial rupture or crevasse formation occurring.

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* See "Through Norway with a Knapsack," chapters xi. and xii., for further descriptions of these.

Let us now follow out some of the necessary results of these conditions of glacier existence and glacial prolongation. The first and most notable, by its contrast with ordinary glaciers, is the absence of lateral, medial, or terminal moraines. The larger masses of *débris,* the chippings that may have fallen from the exposed escarpments of the mountains upon the surface of the upper regions of the glacier, instead of remaining on the surface of the ice and standing above its general level by protecting the ice on which they rest from the general snow-thaw, would become buried by the upward accretion of the ice due to the unthawed stratum of each year's snow-fall.

The thinning agency at work upon such glaciers during their journey over the *terra firma* being the outflow of terrestrial heat and that due to their friction upon their beds, this thinning must all take place from below, and thus, as the glaciers proceed downwards, these rock fragments must be continually approaching the bottom instead of continually approaching the top, as in the case of modern Alpine glaciers flowing below the snow-line, and thawing from surface downwards.

It follows, therefore, that such glaciers could not deposit any moraines such as are in course of deposition by existing Alpine and Scandinavian glaciers.

What, then, must become of the chips and filings of these outfloating glaciers? They must be carried along with the ice *so long as that ice rests upon the land;* for this *débris* must consist partly of fragments imbedded in the ice, and partly of ground and re-ground excessively subdivided particles, that must either cake into what I may call ice-mud, and become a part of the glacier, or flow as liquid mud or turbid water beneath it, as with ordinary glaciers. The quantity of water being relatively small under the supposed conditions, the greater part would be carried forward to the sea by the ice rather than by the water.

An important consequence of this must be that the erosive power of these ancient glaciers was, *cœteris paribus*, greater than that of modern Alpine glaciers, especially if we accept those theories which ascribe an actual internal growth or regeneration of glaciers by the relegation below of some of the water resulting from the surface-thaw.

As the glacier with its lower accumulation advances into deeper and deeper water, its pressure upon its bed must progressively diminish until it reaches a line where it would just graze the bottom with a touch of feathery lightness. Somewhere before reaching this it would begin to deposit its burden on the sea-bottom, the commencement of this deposition being determined by the depth whereat the tenacity of the deposit, or its friction against the sea-bottom, or both combined, becomes sufficient to overpower the now-diminished pressure and forward thrusting, or erosive power of the glacier.

Futher forward, in deeper water, where the ice becomes fairly floated above the original sea-bottom, a rapid underthawing must occur by the action of the sea-water, and if any communication exists between this ice covered sea and the waters of warmer latitudes this thawing must be increased by the currents that would necessarily be formed by the interchange of water of varying specific gravities. Deposition would thus take place in this deeper water, continually shallowing it or bringing up the sea-bottom nearer to the ice-bottom.

This raising of the sea-bottom must occur not only here, but farther back, *i.e.*, from the limit at which deposition commenced. This neutral ground, whereat the depth is just sufficient to allow the ice to rest lightly on its own deposit and slide over it without either sweeping it forward or depositing any more upon it, becomes an interesting critical region, subject to continuous forward extension during the lifetime of the glacier, as the deposition beyond it must continually raise the sea-bottom until it reaches the critical depth at which the deposition must cease. This would constitute what I may designate the normal depth of the glaciated sea, or the depth towards which it would be continually tending, during a great glacial epoch, by the formation of a submarine bank or plain of glacier deposit, over which the glacier would slide without either grinding it lower by erosion or raising it higher by deposition.

But what must be the nature of this deposit? It is evident that it cannot be a mere moraine consisting only of the larger fragments of rock such as are now deposited at the foot of glaciers that die out before reaching the sea. Neither can it correspond to the glacial silt which is washed away and separated from these larger fragments by glacial streams, and deposited at the outspreadings of glacier torrents and rivers. It will correspond to neither the assorted gravel, sand, nor mud of these alluvial deposits, but must be an agglomeration of all the infusible solid matter the gacier is capable of carrying.

It must contain, in heterogeneous admixture, the great boulders, the lesser rock fragments, the gravel chips, the sand, and the slimy mud; these settling down quietly in the cold, gloomy waters, overshadowed by the great ice-sheet, must form just such an agglomeration as we find in the boulder clay and tills, and lie just in those places where these deposits abound, provided the relative level of land and sea during the glacial epoch were suitable.

I should make one additional remark relative to the composition of this deposit, viz., that under the conditions supposed, the original material detached from the rocks around the upper portions of the glaciers would suffer a far greater degree of attrition at the glacier bottom than it obtains in modern Alpine glaciers, inasmuch as in these it is removed by the glacier torrent when it has attained a certain degree of fineness, while in the greater glaciers of the glacial epoch it would be carried much further in association with the solid ice, and be subjected to more grinding and regrinding against the bottom. Hence a larger proportion of slimy mud would be formed, capable of finally induring into stiff clay such as forms the matrix of the till and boulder clay.

The long journey of the bottom *débris* stratum of the glacier, and its final deposition when in a state of neutral equilibrium between its own tendency to repose and the forward thrust of the glacier, would obviously tend to arrange the larger fragments of rock in the manner in which they are found imbedded in the till, *i.e.*, the oblong fragments lying with their longer axes and their best marked striæ in the direction of the motion of the glacier. The "*striated pavements*" of the till are thus easily explained; they are the surface upon which the ice advanced when its deposits had reached the critical or neutral height. Such a pavement would continually extend outwards.

The only sorting of the material likely to occur under these conditions would be that due to the earlier deposition and entanglement of the larger fragments, thus producing a more stony deposit nearer inland, just as Mr. Geikie describes the actual deposits of till where, "generally speaking, the stones are most numerous in the till of hilly districts; while at the lower levels of the country the clayey character of the mass is upon the whole more pronounced." These "hilly districts," upon the supposition of greater submergence, would be the near shore regions, and the lower levels the deeper sea where the glacier floated freely.

The following is Mr. Geikie's description of the distribution of the till (page 13):—"It is in the lower-lying districts of the country where till appears in greatest force. Wide areas of the central counties are covered up with it continuously, to a depth varying from two or three feet up to one hundred feet and more. But as we follow it towards the mountain regions it becomes thinner and more interrupted—the naked rock ever and anon peering through, until at last we find only a few shreds and patches lying here and there in sheltered hollows of the hills. Throughout the Northern Highlands it occurs but rarely, and only in little isolated patches. It is not until we get way from the steep rocky declivities and narrow glens and gorges, and enter upon the broader valleys that open out from the base of the highland mountains to the low-lying districts beyond, that we meet with any considerable deposits of stony clay. The higher districts of the Southern Uplands are almost equally free from any covering of till.'

This description is precisely the same as I must have written, had I so far continued my imaginary sketch of the results of ancient glaciation as to picture what must remain after the glaciers had all melted away, and the sea had receded sufficiently to expose their submarine deposits.

Throughout the above I have assumed a considerable submergence of the land as compared with the present sea-level on the coasts of Scotland, Scandinavia, etc.

The universality of the terraces in all the Norwegian valleys opening westward proves a submergence of *at least* 600 or 700 feet. When I first visited Norway in 1856, I accepted the usual description of these as alluvial deposits; was looking for glacial vestiges in the form of moraines, and thus quite failed to observe the true nature of these vast accumulations, which was obvious enough when I re-examined them in the light of more recent information. Some few are alluvial, but they are exceptional and of minor magnitude. As an example of such alluvial terraces I may mention those near the mouth of the Romsdal, that are well seen from the Aak Hotel, and which a Russian prince, or other soldier merely endowed with military eyes, might easily mistake for artificial earthworks erected for the defence of the valley.

In this case, as in the others where the terraces are alluvial, the valley is a narrow one, occupied by a relatively wide river loaded with recent glacial *débris*. It evidently filled the valley during the period of glacial recession.

The ordinary wider valleys, with a river that has cut a narrow channel through the outspread terrace-flats, display a different formation. Near the mouth of such valleys I have seen cuttings of more than a hundred feet in depth, through an unbroken terrace of most characteristic till, with other traces rising above it. This is the ordinary constitution of the *lower portions* of most of the Scandinavian terraces.

These terraces are commonly topped with quite a different stratum, which at first I regarded as a subsequent alluvial or estuarine deposit, but further examination suggested another explanation of the origin of some portions of this superficial stratum, to which I shall refer hereafter.

Such terraces prove a rise of sea or depression of land, during the glacial epoch, to the extent of 600 feet as a *minimum*, while the well-known deposits of Arctic shells at Moel Tryfaen and the accompanying drift have led Prof. Ramsay to estimate "the probable amount of submergence during some part of the glacial period at about 2300 feet."*

It would be out of place here to reproduce the data upon which geologists have based their rather divergent opinions respecting the actual extent of the submergence of the western coast of North Europe. All agree that a great submergence occurred, but differ only as to its extent, their estimates varying between 1,000 and 3,000 feet.

There is one important consideration that must not be overlooked, viz., that—if my view of the submarine origin of the till be correct—the mere submergence of the land at the glacial period does not measure the difference between the depth of the sea at that and the present time, seeing that the deposits from the glaciers must have shallowed it very materially.

It is only after contemplating thoroughly the present form of the granitic and metamorphic hills of Scandinavia,—hills that are always angular when subjected only to subaerial weathering,—that one can form an adequate conception of the magnitude of this shallowing deposit. The rounding, shaving, grinding, planing, and universal abrasion everywhere displayed appear to me to justify the conclusion that if the sea were now raised to the level of the terraces, *i.e.*, 600 feet higher than at present, the mass of matter abraded from the original Scandinavian mountains, and lying under the sea, would exceed the whole mass of mountain left standing above it.

The first question suggested by reading Mr. Geikie's book was whether the terraces are wholly or partially formed of till, and more especially whether their lower portions are thus composed. This, as already stated, was easily answered by the almost unanimous reply of all the many Norwegian valleys I traversed. Any tourist may verify this. The next question was whether this same till extends below the sea. This was not so easily answered by the means at my disposal, as I travelled hastily round the coast from Stavanger via the North Cape to the frontier of Russian Lapland in ordinary passenger steam-packets, which made their stoppages to suit other requirements than mine. Still, I was able to land at many stations, and found, wherever there was a gently sloping strand at the mouth of an estuary, or of a valley whose river had already deposited its suspended matter (a common case hereabouts, where so many rivers terminate in long estuaries or open out into bag-shaped lakes near the coast), and where the bottom had not been modified by secondary glaciation, that the receding tide displayed a sea-bottom of till, covered with a thin stratum of loose stones and shells. In some cases the till was so bare that it appeared like a stiff mud deposited but yesterday.

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* Lyell, "Elements of Geology," p. 159.

At Bodö, an arctic coast station on the north side of the mouth of the Salten fjord (lat. 67° 20′), where the packets make a long halt, is a very characteristic example of this; a deposit of very tough till forming an extensive plain just on the sea-level. The tide rises over this, and the waves break upon it, forming a sort of beach by washing away some of the finer material, and leaving the stones behind. The ground being so nearly level, the reach of the tide is very great, and thus a large area is exposed at low tide. Continuous with this, and beyond the limit of high tide, is an extensive inland plain covered with coarse grass and weeds growing directly upon the surface of the original flat pavement of till.

There is no river at Bodö; the sea is clear, leaves no appreciable deposit, and the degree of denudation of the clayey matrix of the till is very much smaller than might be expected. The limit of high water is plainly shown by a beach of shells and stones, but at low tide the ground over which the sea has receded is a bare and scarcely modified surface of till. I have observed the same at low water at many other arctic stations. In the Tromsö Sund there are shallows at some distance from the shore which are just covered with water at low tide. I landed and waded on these, and found the bottom to consist of till covered with a thin layer of shells, odd fragments of earthenware, and other rubbish thrown overboard from vessels. It is evident that breakers of considerable magnitude are necessary for the loosening of this tough compact deposit—that it is very slightly, if at all, affected by the mere flow of running water.

I specify these instances as characteristic and easy of verification, as the packets all stop at these stations; but a yachtsman sailing at leisure amidst the glorious coast scenery of the Arctic Ocean might multiply such observations a hundredfold by stopping wherever such strands are indicated in passing. I saw a multitude of these in places where I was unable to go ashore and examine them.

A further question in this direction suggested itself on the spot, viz., what is the nature of the "*banks*" which constitute the fishing-grounds of Norway, Iceland, Newfoundland, etc. They are submarine plains unquestionably—they must have a high degree of fertility in order to supply food for the hundreds of millions of voracious cod-fish, coal-fish, haddocks, hallibut, etc., that people them. These large fishes all *feed on the bottom*, their chief food being mollusca and crustacea, which must find, either directly or indirectly, some pasture of vegetable origin. The banks are, in fact, great meadows or feeding grounds for the lower animals which support the higher.

From the Lofoten bank alone twenty millions of cod-fish are taken annually, besides those devoured by the vast multitude of sea-birds. Now this bank is situated precisely where, according to the above-stated view of the origin of the till, there should be a huge deposit. It occupies the Vest fjord, *i.e.*, the opening between the mainland and the Lofoden Islands, extending from Moskenes, to Lodingen on Hindö, just where the culminating masses of the Kjolen Mountains must have poured their greatest glaciers into the sea by a westward course, and these glaciers must have been met by another stream pouring from the north, formed by the glaciers of Hindö and Senjenö, and both must have coalesced with a third flood pouring through the Ofoten fjord, the Tys fjord, etc., from the mainland. The Vest fjord is about sixty miles wide at its mouth, and narrows northward till it terminates in the Ofoten fjord, which forks into several branches eastward. A glance at a good map will show that here, according to my explanation of the origin of the till, there should be the greatest of all the submarine plains of till which the ancient Scandinavian glaciers have produced, and of which the plains of till I saw on the coast at Bodö (which lies just to the mouth of the Vest fjord, where the Salten fjord flows into it), are but the slightly inclined continuation.

Some idea of this bank may be formed from the fact that outside of the Lofodens the sea is 100 to 200 fathoms in depth, that it suddenly shoals up to 16 or 20 fathoms on the east side of these rocks, and this shallow plain extends across the whole 50 or 60 miles between these islands and the mainland.* It must not be supposed the fjords or inlets of Scandinavia are *usually* shallower than the open sea; the contrary is commonly the case, especially with the norrowest and those which run farthest inland. They are *very much* deeper than the open sea.

If space permitted I could show that the great Storregen bank, opposite Aalesund and Molde, where the Stor fjord, Mold fjord, etc., were the former outlets of the glaciers from the highest of all the Scandinavian mountains, and the several banks of Finmark, etc., from which, in the aggregate, are taken another 20 or 30 millions of cod-fish annually, are all situated just where theoretically they ought to be found. The same is the case with the great bank of Newfoundland and the banks around Iceland, which are annually visited by large numbers of French fishermen from Dunkerque, Boulogne, and other ports.

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* The celebrated "Maelström" is one of the currents that flow down the submarine incline between these islands when the tide is falling. Although I have ridiculed some of the accounts of this now innocent stream, I am not prepared to assert that it was always as mild as at present. If the ancient glaciers were stopped suddenly, as they may well have been, by the rocky barrier of Mosken, between Vaerö and Moskenesö, and they then suddenly concluded their deposition of till, a precipice must have been formed between this and the deep sea outside the islands, down which the sea would pitch when the tide was falling, and thus form some dangerous eddies. This cascade would gradually obliterate itself by wearing down the precipitous wall to an inclined plane such as at present exists, and down which the existing current flows.

Whenever the packet halted over these banks during our coasting trip we demonstrated their fertility by casting a line or two over the bulwark. No bait was required, merely a double hook with a flat shank attached to a heavy leaden plummet. The line was sunk till the lead touched the bottom, a few jerks were given, and then a tug was felt: the line was hauled in with a cod-fish or hallibut hooked, not inside the mouth, but externally by the gill-plates, the back, the tail, or otherwise. The mere jerking of a hook near the bottom was sufficient to bring it in contact with some of the population. There is a very prolific bank lying between the North Cape and Nordkyn, where the Porsanger and Laxe fjords unite their openings. Here we were able, with only three lines, to cover the fore-deck of the packet with struggling victims in the course of short halts of fifteen to thirty minutes. Not having any sounding apparatus by which to fairly test the nature of the sea-bottom in these places, I cannot offer any direct proof that it was composed of till. By dropping the lead I could *feel* it sufficiently to be certain that it was not rock in any case, but a soft deposit, and the marks upon the bottom of the lead, so far as they went, afforded evidence in favor of its clayey character. A further investigation of this would be very interesting.

But the most striking—I may say astounding—evidence of the fertility of these banks, one which appeals most powerfully to the senses, is the marvelous colony of sea-birds at Sverholtklubben, the headland between the two last-named fjords. I dare not estimate the numbers that rose from the rocks and darkened the sky when we blew the steam-whistle in passing. I doubt whether there is any other spot in the world where an equal amount of animal life is permanently concentrated. All these feed on fish, and an examination of the map will show why—in accordance with the above speculations—they should have chosen Sverholtklubben as the best fishing-ground on the arctic face of Europe.

I am fully conscious of the main difficulty that stands in the way of my explanation of the formation of the till, viz., that of finding sufficient water to float the ice, and should have given it up had I accepted Mr. Geikie's estimate of the thickness of the great ice-sheet of the great ice age.

He says (page 186) that "The ice which covered the low grounds of Scotland during the early cold stages of the glacial epoch was certainly more than 2000 feet in thickness, and it must have been even deeper than this between the mainland and the Outer Hebrides. To cause such a mass to float, the sea around Scotland would require to become deeper than now by 1400 or 1500 feet at least."

I am unable to understand by what means Mr. Geikie measured this depth of the ice which covered these low grounds, except by assuming that its surface was level with that of the upper ice-marks of the hills beyond. The following passage on page 63 seems to indicate that he really has measured it thus:—

"Now the scratches may be traced from the islands and the coast-line up to an elevation of at least 3,500 feet; so that ice must have covered the country to that height at least. In the Highlands the tide of ice streamed out from the central elevations down all the main straths and glens; and by measuring the height attained by the smoothed and rounded rocks we are enabled to estimate roughly the probable thickness of the old ice-sheet. But it can only be a rough estimate, for so long a time has elapsed since the ice disappeared, the rain and frost together have so split up and worn down the rocks of these highland mountains that much of the smoothing and polishing has vanished. But although the finer marks of the ice-chisel have thus frequently been obliterated, yet the broader effects remain conspicuous enough. From an extensive examination of these we gather that the ice could not have been less, and was probably more than 3,000 feet thick in its deepest parts."

Page 80 he says: "Bearing in mind the vast thickness reached by the Scotch ice-sheet, it becomes very evident that the ice would flow along the bottom of the sea with as much ease as it poured across the land, and every island would be surmounted and crushed, and scored and polished just as readily as the hills of the mainland were."

Mr. Geikie describes the Scandinavian ice-sheet in similar terms, but ascribes to it a still greater thickness. He says (page 404)—"The whole country has been moulded and rubbed and polished by an immense sheet of ice, which could hardly have been less than 6,000 or even 7,000 feet thick," and he maintains that this spread over the sea and coalesced with the ice-sheet of Scotland.

My recollection of the Lofoden Islands, which from their position afford an excellent crucial test of this question, led me to believe that their configuration presented a direct refutation of Mr. Geikie's remarkable inference; but a mere recollection of scenery being too vague, a second visit was especially desirable in reference to this point. The result of the special observations I made during this second visit fully confirmed the impression derived from memory.

I found in the first place that all along the coast from Stavanger to the Varanger fjord every rock *near the shore* is glaciated; among the thousands of low-lying ridges that peer above the water to various heights none near the mainland are angular. The general character of these is shown in the sketch of "My Sea Serpent," in the last edition of "Through Norway with a Knapsack."

The rocks which constitute the extreme outlying limits of the Lofoden group, and which are between 60 and 70 miles from the shore, although mineralogically corresponding with those near the shore, are totally different in their conformation, as the sketch of three characteristic specimens plainly shows. Mr. Everest very aptly compares them to shark's teeth. Proceeding northward, these rocks gradually progress in magnitude, until they become mountains of 3,000 to 4,000 feet in height; their outspread bases form large islands, and the Vest fjord gradually narrows.

The remarkably angular and jagged character of these rocks when weathered in the air renders it very easy to trace the limits of glaciation on viewing them at a distance. The outermost and smallest rocks show from a distance no signs of glaciation. If submerged, the ice of the great ice age was then enough to float over without touching them; if they stood above the sea, as at present, they suffered no more glaciation than would be produced by such an ice-sheet as that of the "paleocrystic" ice recently found by Captain Nares on the north of Greenland. Progressing northward, the glaciation begins to become visible, running up to about 100 feet above the sea-level on the islands lying westward and southward of Ost Vaagen. Further northward along the coast of Ost Vaagen and Hindõ, the level gradually rises to about 500 feet on the northern portion of Ost Vaagen, and up to more than 1,000 feet on Hindõ, while on the mainland it reaches 3,000 to 4,000 feet.

A remarkable case of such variation, or descent of ice-level, as the ice-sheet proceeded seaward, is shown at Tromsö. This small oblong island (lat. 69° 40′), on which is the capital town of Finmark, lies between the mainland and the large mountainous island of Kvalö, with a long sea-channel on each side, the Tromösund and the Sandesund; the total width of these two channels and the island itself being about four or five miles. The general line of glaciation from the mainland crosses the broad side of these channels and the island, which has evidently been buried and ground down to its present moderate height of two or three hundred feet. Both of the channels are till paved. On the east or inland side the mountains near the coast are glaciated to their summits—are simply *roches moutonnées,* over which the reindeer of the Tromsdal Lapps range and feed. On the west the mountains are dark, pyramidal, non-glaciated peaks, with long vertical snow-streaks marking their angular masses.

The contrast is very striking when seen from the highest part of the island, and is clearly due to a decline in the thickness of the ice-sheet in the course of its journey across this narrow channel. Speaking roughly from my estimation, I should say that this thinning or lowering of the limits of glaciation exceeds 500 feet between the opposite sides of the channel, which, allowing for the hill slopes, is a distance of about 6 miles. This very small inclination would bring a glacier of 3,000 feet in thickness on the shore down to the sea-level in an outward course of 30 miles, or about half the distance between the mainland and the outer rocks of the Lofodens shown in the engraving.

I am quite at a loss to understand the reasoning upon which Mr. Geikie bases his firm conviction respecting the depth of the ice-sheet on the low grounds of Scotland and Scandinavia. He seems to assume that the glaciers of the great ice age had little or no superficial down slope corresponding to the inclination of the base on which they rested. I have considerable hesitation in attributing this assumption to Mr. Geikie, and would rather suppose that I have misunderstood him, as it is a conclusion so completely refuted by all we know of glacier phenomena and the physical laws concerned in their production; but the passages I have quoted, and several others, are explicit and decided.

Those geologists who contend for the former existence of a great polar ice-cap radiating outwards and spreading into the temperate zones, might adopt this mode of measuring its thickness, but Mr. Geikie rejects this hypothesis, and shows by his map of "The Principal Lines of Glacial Erosion in Sweden, Norway, and Finland," that the glaciation of the extreme north of Europe proceeded from south to north; that the ice was formed on land, and proceeded seawards in all directions.

I may add to this testimony that presented by the North Cape, Sverholt, Nordkyn, and the rest of the magnificent precipitous headlands that constitute the characteristic feature of the arctic face of Europe. They stand forth defiantly as a phalanx of giant heralds proclaiming aloud the fallacy of this idea of southward glacial radiation; and in concurrence with the structure and striation of the great glacier troughs that lie between them, and the planed tableland at their summits, they establish the fact that during the greatest glaciation of the glacial epoch the ice-streams were formed on land and flowed out to sea, just as they now do at Greenland, or other parts of the world where the snow line touches or nearly approaches the level of the sea.

All such streams must have followed the slope of the hill-sides upon which they rested and down which they flowed, and thus the upper limits of glaciation afford no measure whatever of the thickness of the ice upon "the low grounds of Scotland," or of any other glaciated country. As an example, I may refer to Mont Blanc. In climbing this mountain the journey from the lower ice-wall of the Glacier de Bessons up to the *bergschrund* above the *Grand Plateau* is over one continuous ice-field, the level of the upper part of which is more than 10,000 feet above its terminal ice-wall. Thus, if we take the height of the striations or smoothings of the upper *nevé* above the low grounds on which the ice-sheet rests, and adopt Mr. Geikie's reasoning, the lower ice-wall of the Glacier de Bessons should be 10,000 feet thick. Its actual thickness, as nearly as I can remember, is about 10 or 12 feet.

Every other known glacier presents the same testimony. The drawing of a Greenland glacier opposite page 47 of Mr. Geikie's book shows the same under arctic conditions, and where the ice-wall terminates in the sea.

I have not visited the Hebrides, but the curious analogy of their position to that of the Lofodens suggests the desirability of similar observations to those I have made in the latter. If the ice between the mainland and the Outer Hebrides was, as Mr. Geikie maintains, "certainly more than 2000 feet in thickness," and this stretched across to Ireland, besides uniting with the still thicker ice-sheet of Scandanavia, these islands should all be glaciated, especially the smaller rocks. If I am right, the smaller outlying islands, those south of Barra, should, like the corresponding rocks of the Lofodens, display no evidence of having been overswept by a deep "*mer de glace.*"

I admit the probability of an ice-sheet extending as Mr. Geikie describes, but maintain that it thinned out rapidly seaward, and there became a mere ice-floe, such as now impedes the navigation of Smith's Sound and other portions of the Arctic Ocean. The Orkneys and Shetlands, with which I am also unacquainted, must afford similar crucial instances, always taking into account the fact that the larger islands may have been independently glaciated by the accumulations due to their own glacial resources. It is the small rocks standing at considerable distance from the shores of larger masses of land that supply the required test-conditions.

From the above it will be seen that I agree with Mr. Geikie in regarding the till as a "*moraine profonde,*" but differ as to the mode and place of its deposition." He argues that it was formed under glaciers of the thickness he describes, while their whole weight rested upon it.

This appears to me to be physically impossible. If such glaciers are capable of eroding solid rocks, the slimy mud of their own deposits could not possibly have resisted them. The only case where this might have happened is where a mountain-wall has blocked the further downward progress of a glacier, or in pockets, or steep hollows which a glacier might have bridged over and filled up; but such pockets are by no means the characteristic localities of till, though the till of Switzerland may possibly show examples of the first case. The great depth of the inland lakes of Norway, their bottoms being usually far below that of the present sea-bottom, is in direct contradiction of this.* They should, before all places, be filled with till, if the till were a ground moraine formed on land; but all we know of them confirms the belief that the glaciers deepened them by erosion instead of shallowing them by deposition.

Mr. Geikie's able defence of Ramsay's theory of lake-basin erosion is curiously inconsistent with his arguments in favor of the ground moraine.

I fully concur with Mr. Geikie's arguments against the iceberg theory of the formation of the till. This, I think, he has completely refuted.

Before concluding I must say a few words on those curious lenticular beds of sand and gravel in the till which appear so very puzzling. A simple explanation is suggested in connection with the above-sketched view of the formation of the till. All glaciers, whether in arctic or temperate climates, are washed by streamlets during summer, and these commonly terminate in the form of a stream or cascade pouring down a "*moulin*"—a well bored by themselves and reaching the bottom of the glacier. Now what must be the action of such a downflow of water upon my supposed submarine bed of till just grazing the bottom of the glacier? Obviously, to wash away the fine clayey particles, and leave behind the coarser sand or gravel. It must form just such a basin or lenticular cavity as Mr. Geikie describes. The oblong shape of these, their longer axis coinciding with the general course of the glacier, would be produced by the onward progress of the moulin. The accordance of their other features with this explanation will be seen on reading Mr. Geikie's description (pp. 18, 19, etc).

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*The largest of the Norwegian lakes, the Mjosen, is 1550 feet deep, and its surface 385 feet above the sea-level. Its bottom is about 1000 feet lower than the sea outside, or 500 to 800 feet below the bottom of the Christiana Fjord. The fjords, generally speaking, are very much shallower near their mouths than further inland, as though their depth had been determined by the thickness of the glaciers flowing down them, and the consequent limits of flotation and deposition.

The general absence of marine animals and their occasional exceptional occurrence in the intercalated beds is just what might be expected under the conditions I have sketched. In the gloomy subglacial depths of the sea, drenched with continual supplies of fresh water and cooled below the freezing-point by the action of salt water on the ice, ordinary marine life would be impossible; while, on the other hand, any recession of the glacial limit would restore the conditions of arctic animal life, to be again obliterated with the renewed outward growth of the floating skirts of the inland ice-mantle.

But I must now refrain from the further discussion of these and other collateral details, but hope to return to them in another paper.

In "Through Norway with Ladies" I have touched lightly upon some of these, and have more particularly described some curious and very extensive evidences of secondary glaciation that quite escaped my attention on my first visit, and which, too, have been equally overlooked by other observers. In the above I have endeavored to keep as nearly as possible to the main subject of the origin of the till and the character of the ancient ice-sheet.

THE BAROMETER AND THE WEATHER.

The barometer was invented by Torricelli, an Italian philosopher of the seventeenth century. It consists essentially of a long tube open at one end and closed at the other, and partly filled with mercury; but instead of being filled like ordinary vessels, with the open end or mouth upwards and the closed end or bottom downwards, the barometer-tube is inverted, and has its open mouth downwards. This open mouth is either dipped into a little cup of mercury or bent a little upwards.

Why does not the mercury run out of this lower open end and overflow the little cup when it is inverted after being filled?

The answer to this question includes the whole mystery and principle of the barometer. The mercury does not fall down because something pushes it up and supports it with a certain degree of pressure, and that something is the atmosphere which extends all round the world, and presses downwards and sideways and upwards—in every direction, in fact—with a force equal to its weight, *i.e.*, with a pressure equal to about 15 lbs. on every square inch. A column or perpendicular square stick of air one inch thick each way, and extending from the surface of the sea up to the top of the atmosphere, weighs about 15 lbs.; other columns or sticks next to it on all sides weigh the same, and so on with every portion; and all these are for ever squeezing down and against each other, and, being fluid, transmit their pressure in every direction, and against the earth and everything upon it, and therefore upon the mercury of the barometer-tube.

We have supposed the air to be made up of columns or sticks of air one inch each way, but might have taken any other size, and the weight and pressure would be proportionate. Now mercury, bulk for bulk, is so much heavier than air, that a stick or column of this liquid metal about 30 inches high weighs as much as a stick or column of air of same thickness reaching from the surface of the earth to the top of the atmosphere; therefore, the 30-inch stick of mercury balances the pressure of the many miles of atmosphere, and is supported by it. Thus the column of mercury may be used to counterbalance the atmosphere and show us its weight; and such a column of mercury is a barometer, or "weight measure." The word *barometer* is compounded of the two Greek words—*baros*, weight, and *metron*, a measure.

If you take a glass tube a yard long, stopped at one end and open at the other, fill it with mercury, stop the open end with your thumb, then invert the tube and just dip the open end in a little cup of mercury, some of the mercury in the tube will fall into the cup, but not all; only six inches will fall, the other 30 inches will remain, with an empty space between it and the stopped end of the tube. When you have done this you will have made a rude barometer. If you prop up the tube, and watch it carefully from day to day, you will find that the height of the column of mercury will continually vary. If you live at the sea-level, or thereabouts, it will sometimes rise more than 30 inches above the level of the mercury in the cup, and frequently fall below that height. If you live on the top of a high mountain, or on any high ground, it will never reach 30 inches, will still be variable, its average height less than if you lived on lower ground; and the higher you go the less will be this average height of the mercury.

The reason of this is easily understood. When we ascend a mountain we leave some portion of the atmosphere below us, and of course less remains above; this smaller quantity must have less weight and press the mercury less forcibly. If the barometer tells the truth, it must show this difference; and it does so with such accuracy that by means of a barometer, or rather of two barometers—one at the foot of the mountain and one at its summit—we may, by their difference, measure the height of the mountain provided we know the rules for making the requisite calculations.

The old-fashioned barometer, with a large dial-face and hands like a clock, is called the "wheel barometer," because the mercury, in rising and falling, moves a little glass float resting upon the mercury of the open bent end of the tube; to this float and its counterpoise a fine cord is attached;

and this cord goes round a little grooved wheel to which the hands are attached. Thus the rising and falling of the mercury moves the float, the float-cord turns the wheel, and the wheel moves the hands that points to the words and figures on the dial. When this hand moves towards the right, or in the direction of an advancing clock-hand, the barometer is rising; when it goes backwards, or opposite to the clock-hand movement, the mercury is falling. By opening the little door at the back of such a barometer, the above-described mechanism is seen. In doing this, or otherwise moving your barometer, be careful always to keep it upright.

It sometimes happens to these wheel barometers that they suddenly cease to act; and in most cases the owner of the barometer may save the trouble and expense of sending it to the optican by observing whether the cord has slipped from the little wheel, and if so, simply replacing it in the groove upon its edge. If, however, the mischief is caused by the tube being broken, which is seen at once by the mercury having run out, the case is serious, and demands professional aid.

The upright barometer, which shows the surface of the mercury itself, is the most accurate instrument, provided it is carefully read. This form of instrument is always used in meteorological observatories, where minute corrections are made for the expansion and contraction which variations of temperature produce upon the length of the mercury without altering its weight, and for the small fluctuations in the level of the mercury cistern. With such instruments, fitted with an apparatus called a "vernier" the height of the mercury may be read to hundredths of an inch.

The necessity for the 30 inches of mercury renders the mercurial barometer a rather cumbrous instrument: it must be more than 30 inches long, and is liable to derangement from the spilling of the mercury. On this account portable barometers of totally different construction have been invented. The "aneroid" barometer is one of these—the only one that is practically used to any extent. It contains a metal box partly filled with air; one face of the box is corrugated, and so thin that it can rise and fall like a stretched covering of india-rubber. As the pressure of the outside air varies it does rise and fall, and by a beautifully-delicate apparatus this rising and falling is magnified and represented upon the dial. Such barometers are made small enough to be carried in the pocket, and are very useful for measuring the heights of mountains; but they are not quite so accurate as the mercurial barometer, and are therefore not used for rigidly scientific measurements; but for all ordinary purposes they are accurate enough, provided they are occasionally compared with a standard mercurial barometer, and adjusted by means of a watch-key axis provided for that purpose, and seen on the back of the instrument. They are sufficiently delicate to tell the traveller in a railway whether he is ascending or descending an incline, and will indicate the difference of height between the upper and lower rooms of a three-story house. With due allowance for variations of level, the traveler may use them as weather indicators; especially as it is the direction in which the barometer is moving (whether rising or falling) rather than its absolute height that indicates changes of weather. Thus by placing the aneroid in his room on reaching his hotel at night, carefully marking its height then and there, and comparing this with another observation made on the following morning, he may use it as a weather-glass in spite of hill and dale.

Water barometers have been made on the same principle as the mercury barometer; but as water is 13½ times lighter, bulk for bulk, than mercury, the height of the column must be 13½ times 30 inches, or, allowing for variations, not less than 34 feet. This, of course, is very cumbrous; the evaporation of the water presents another considerable difficulty,* still such a barometer is a very interesting instrument, as it shows the atmospheric fluctuations on 13½ times the scale of the ordinary barometer. A range of about five feet is thus obtained; and not only the great waves, but even the comparatively small ripples of the atmospheric ocean are displayed by it. In stormy weather it may be seen to rise and fall and pulsate like a living creature, so sensitively does it respond to every atmospheric fluctuation.

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* This has been recently overcome to a great extent by using glycerine instead of water.

But why should the height of the barometer vary while it remains in the same place?

If the quantity of air surrounding the earth remains the same, and if the barometer measures its weight correctly, why should the barometer vary?

Does the atmosphere grow bigger and smaller, lighter and heavier, from time to time?

These are fair questions, and they bring us at once to some of the chief uses of the barometer. The atmosphere is a great gaseous ocean surrounding the earth, and we are creeping about on the bottom of this ocean. It has its tides and billows and whirling eddies, but all these are vastly greater than those of the watery ocean. At one time we are under the crest or rounded portion of a mighty atmospheric wave, at another the hollow between two such waves is over our heads, and thus the depth of atmosphere, or quantity of air, above us is variable. This variation is the combined result of many co-operating causes. In the first place, there are great atmospheric tides, caused, like those of the sea, by the attraction of the sun and moon; but these do not *directly* affect the barometer, because the attracting body supports whatever it lifts. Variations of temperature also produce important fluctuations in the height and density of the atmosphere, some of which are indicated by the barometer—others are not. Thus a mere expansion or contraction of *dry* air, increasing the depth or the density of the atmospheric ocean, would not affect the barometer, as mere expansion and contraction only alter the *bulk* without affecting the *weight* of the air. But our atmosphere consists not only of the permanent gases, nitrogen and oxygen; it contains besides these and carbonic acid, a considerable quantity of gaseous matter, which is not permanent, but which may be a gas at one moment—contributing its whole weight to that of the general atmosphere—and at another moment some of it may be condensed into liquid particles that fall through it more or less rapidly, and thus contribute nothing to its weight.

What, then, is this variable constituent that sometimes adds to the weight of the atmosphere and the consequent height of the baromerer, and at others may suddenly cease to afford its full contribution to atmospheric pressure?

It is simply water, which, as we all know, exists as solid, liquid, or gas, according to the temperature and pressure to which it is exposed. We all know that steam when it first issues from the spout of a tea-kettle is a transparent gas, or true vapor, but that presently, by contact with the cool air, it becomes white, cloudy matter, or minute particles of water; and that, if these are still further cooled, they will become hoar-frost or snow, or solid ice. Artificial hoar-frost and snow may be formed by throwing a jet of steam into very cold, frosty air. If you take a tin canister or other metal vessel, fill it with a mixture of salt with pounded ice or snow, and then hold the outside of the canister against a jet of steam, such as issues from the spout of a tea-kettle, a snowy deposit of hoar-frost will coat the outside of the tin. Now let us consider what takes place when a warm south-westerly wind, that has swept over the tropical regions of the Atlantic ocean, reaches the comparatively cold shores of Britain. It is cooled thereby, and some of its gaseous water is condensed—forming mists, clouds, rain, hoar-frost or snow. The greater part of this forms and falls on the western coasts, on Cornwall, Ireland, the Western Highlands of Scotland. Ireland gets the lion's share of this humidity, and hence her "emerald" verdure. The western slope of a mountain, in like manner, receives more rain than the side facing the east.

How does this condensation affect the barometer?

It must evidently cause it to fall, inasmuch as the air must be lightened to the exact extent of all that is taken out of it and precipitated. But the precipitation is not completed immediately the condensation occurs. It takes some time for the minute cloudy particles to gather into rain drops and fall to the earth, while the effect of the condensation upon the barometer is instantaneous; the air begins to grow lighter immediately the gas is converted into cloud or mist, and the barometer falls just at the same time and same rate as this is produced; but the rain comes some time afterwards. Hence the use of the barometer as a "weather glass." When intelligently and properly used it is very valuable in this capacity; but, like most things, it may easily be misunderstood and misused.

The most common error in the use of the barometer is that to which people are naturally led by the words engraved upon it, "Stormy, Much Rain, Rain, Change, Fair, Set Fair," etc. A direct and absolute blunder or falsehood is usually short-lived, and deceives but few people; but a false statement, with a certain amount of superficial truth, may survive for ages, and deceive whole generations. Now this latter is just the character of the weather signs that are engraved on our popular barometers; they are unsound and deceptive, but not utterly baseless.

Stormy, *Much Rain*, and *Rain* are marked against the low readings of the barometer, and *Very Dry*, *Set Fair*, and *Fair* against the higher readings. A low barometer is not a reliable sign of wet or stormy weather, neither is a high barometer to be depended upon for expecting fine weather; and yet it is true that we are more likely to have fine weather with a high than with a low barometer, and also the liability to rain and storms is greater with a low than with a high barometer.

The best indications of the weather are those derived from the direction in which the barometor is moving—whether rising or falling—rather than its mere absolute height.

A sudden and considerable fall is an almost certain indication of strong winds and stormy weather. This is the most reliable of the prophetic warnings of the barometer, and the most useful, inasmuch as it affords the mariner just the warning he requires when lying off a dangerous coast, or otherwise in peril by a coming gale. Many a good ship has been saved by intelligent attention to the barometer, and by running into haven, or away from a rocky shore when the barometer has fallen with unusual rapidity.

The next in order of reliability is the indication afforded by a steady and continuous fall after a long period of fine weather. This is usually followed by a decided change of weather, and the greater the fall the more violent the change. If the fall is slow, and continues steadily for a long time, the change is likely to be less sudden but more permanent, *i.e.*, the rain will probably arrive after some time, and then continue steadily for a long period.

In like manner, a steady, regular rise, going on for some days in the midst of wet weather, may be regarded as a hopeful indication of coming continuous fine weather—the more gradual and steady the rise, the longer is the fine weather likely to last.

The least reliable of all the barometric changes is a sudden rise. In winter it may be followed by hard and sudden frost, in summer by sultry weather and thunder-storms. All that may be safely said of such sudden rise is, that it indicates a change of some sort.

The barometer is usually high with N.E. winds, and low with S.W. winds. The preceding explanations show the reason of this. In a given place the extreme range of variation is from 2 to 2½ inches.

It has been proposed that the following rules should be engraved on barometer-plates instead of the usual words:—

1st. Generally, the rising of the mercury indicates the approach of fair weather; the falling of it shows the approach of foul weather.

2d. In sultry weather, the fall of the barometer indicates coming thunder. In winter, the rise of the mercury indicates frost. In frost, its fall indicates thaw, and its rise indicates snow.

3d. Whatever change in the weather suddenly follows a change in the barometer, may be expected to last but a short time.

4th. If fair weather continues for several days, during which the mercury continually falls, a long succession of foul weather will probably ensue; and again, if foul weather continues for several days, while the mercury continually rises, a long succession of fair weather will probably follow.

5th. A fluctuating and unsettled state of the mercurial column indicates changeable weather.

As the barometer is subject to slight diurnal variations, irrespective of those atmospheric changes which affect the weather, it is desirable in making comparative observations to do so at fixed hours of the day. Nine or ten in the morning and same hour in the evening are good times for observations that are to be recorded. These are about the hours of daily maxima or highest readings due to regular diurnal variation.

The true reading of the barometer is the height at which it would stand if placed at the level of the sea at high tide; but, as barometers are always placed more or less above this level, a correction for elevation is necessary. When the height of the place is known this correction may be made by adding one tenth of an inch to the actual reading for every 85 feet of elevation up to 510 feet; the same for every 90 feet between 510 and 1.140 feet, for every 95 feet between 1140 and 1900 feet, and for every 100 feet above this and within our mountain limits. This simple and easy rule is sufficiently accurate for practical purposes. Thus, a barometer on Bray Head, or any place 800 feet above the sea, would require a correction of six-tenths for the first 510 feet, and a little more than three-tenths more for the remaining 290 feet. Therefore, if such a barometer registered the pressure at $29\frac{1}{10}$, the proper sea-level reading would be a little above 30 inches.

The most important prognostications of the barometer are those afforded by what is called the "barometric gradient or incline," showing the up-hill and down-hill direction of the atmospheric inequalities; but this can only be ascertained by comparing the state of the barometer at different stations at the same time. Thus, if the barometer is one-fourth of an inch higher at Dublin than at Galway, and the intermediate stations show intermediate heights, there must be an atmospheric down-hill gradient from Dublin to Galway; Dublin must be under the upper and Galway under the lower portion of a great atmospheric wave or current. It is evident that when there is thus more air over Dublin than over Galway, there must follow (if nothing else interferes) a flow of air from Dublin towards Galway. It is also evident that, in order to tell what else may interfere, we must know the atmospheric gradients beyond and around both Dublin and Galway, and for considerable distances.

We are now beginning to obtain such information by organizing meteorological stations and observatories, and transmitting the results of simultaneous observations by means of the electric telegraph to certain head-quarters.

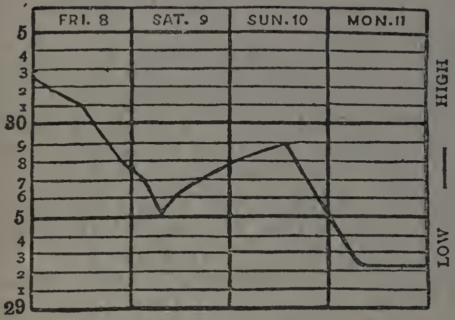
The subject is occupying much attention, and the managers of those splendid monuments of British energy—our daily newspapers—are publishing daily weather charts, and therefore a few simple explanations of the origin, nature, and significance of such charts will doubtless be appreciated by our readers.

The grand modern improvement of the barometer, the thermometer, the anemometer, the pluviometer, etc., is that of making them "self-registering." We are told that Cadmus invented the art of writing, and we honor his memory accordingly. But he ventured no further than teaching human beings to write. Modern meteorologists have gone much further; they have taught the winds and the rains and the subtle heavings of the invisible air to keep their own diaries, to write their own histories on paper that is laid before them, with pencils that are placed in their fleshless, boneless, and shapeless fingers. This achievement is wrought by comparatively simple means. The paper is wound upon an upright drum or cylinder, and this cylinder is made to revolve by clock-work, in such a manner that a certain breadth travels on during the twenty-four hours. This breadth of paper is divided by vertical lines into twenty-four parts, each of which passes onward in one hour. Connected with the barometer is a pencil which, by means of a spring, presses lightly upon the revolving sheet, and this pencil, while thus pressing, rises and falls with the mercury. It is obvious that, in this manner, a line will be drawn as the paper moves. If the mercury is stationary, the line will be horizontal—only indicating the movement of the drum; if the mercury falls, the line will slope downwards; if it rises, it will incline upwards. By ruling horizontal lines upon the paper, representing inches, tenths, and smaller fractions, if desired, the whole history of the barometrical movements will be graphically recorded by the waving or zigzag lines thus drawn by the atmosphere itself.

The subjoined copy of the *Daily Telegraph* Barometer Chart represents, on a small scale, a four days' history of barometrical movements:

The large figures at the side (29 and 30) represent inches; the smaller figures tenths of inches.

The pressure of the wind is similarly pictured by means of a large vane which turns with the wind, and to the windward face of which a flat board or plate of metal, one foot square, is attached perpendicularly. As the wind strikes this it presses against it with a force corresponding to a certain number of pounds, ounces, and fractions of an ounce. A spring like that of an ordinary spring letter-balance is compressed in proportion to this pressure. This movement of the spring is transmitted mechanically to another pencil like the above described, working against the same drum; thus another history is written on the same paper—the horizontal lines now representing fractions of pounds of pressure, instead of fractions of inches of mercury.



It has been found that if a semi-globular cup of thin metal is exposed to the wind, the pressure upon the round or convex side of the hemisphere is equal to two thirds of that upon the hollow or concave side. By placing four such cups upon cross-arms, and the arms on a pivot, the wind, from whatever quarter it may come, will always blow them round with their convex faces foremost; and they will move with one third of the actual velocity of the wind. By a simple clock-work arrangement, these arms move another pencil, in such a manner that it strikes the paper hammer-fashion every time the wind has completed a journey of one mile, or other given distance; and thus a series of dots upon the revolving paper records the velocity of the wind according to their distances apart. As the pressure of the wind is governed by two factors, viz., the density and velocity of the moving air, the relations between the barometer curve, the pressure curve, and the velocity dots, are very interesting.

The direction of the wind is written by a pencil fixed to a quick worm—a screw-thread upon the axis of the vane. As the vane turns round—N., E., S., or W.—it screws the pencil up or down, and thus the horizontal lines first described as registering tenths of inches of barometric pressure do duty as showing the points of the compass from which the wind is blowing; and, by reference to the zigzag line drawn by this pencil of the wind, its direction at any particular time of day may be ascertained as certified by its own sign-manual.

The wind-gauge is called an anemometer. Connected with this is the pluviometer, or rain-gauge—an upright vessel with an open mouth of measured area—say 100 square inches. This receives the rain that falls. By means of a pipe the water is conveyed to a vessel having a surface of—say one square inch. By this arrangement, when sufficient rain has fallen to cover the surface of the earth to the depth of one hundredth of an inch, the little vessel below will contain water one inch in depth. By balancing this vessel at the end of a long arm, it is made to preponderate gradually as the weight of water it receives increases, and finally, when filled, it tips over altogether, empties itself, and then rises to its starting place in equilibrium. To the other end of this arm a pencil is attached, which inscribes all these movements on the revolving paper, and thus tells the history of the rainfall. The line is zigzag while the rain is falling, and horizontal while the weather is fair. The amount of inclination of the zigzag line measures the depth of rain by means of the same ruled lines on the paper as measure the height of the barometer, etc. Every time the measuring vessel tips over a perpendicular line is drawn, and the pencil resumes its starting level. The papers containing these autographs of the elements may, of course, be kept as permanent records for reference whenever needed, or the results may be tabulated in other forms.

There are many modifications in the details of these self-registering instruments. In some of them photography is made to do a part of the work. The above description indicates the main principles of their construction, without attempting to enter upon minute details.

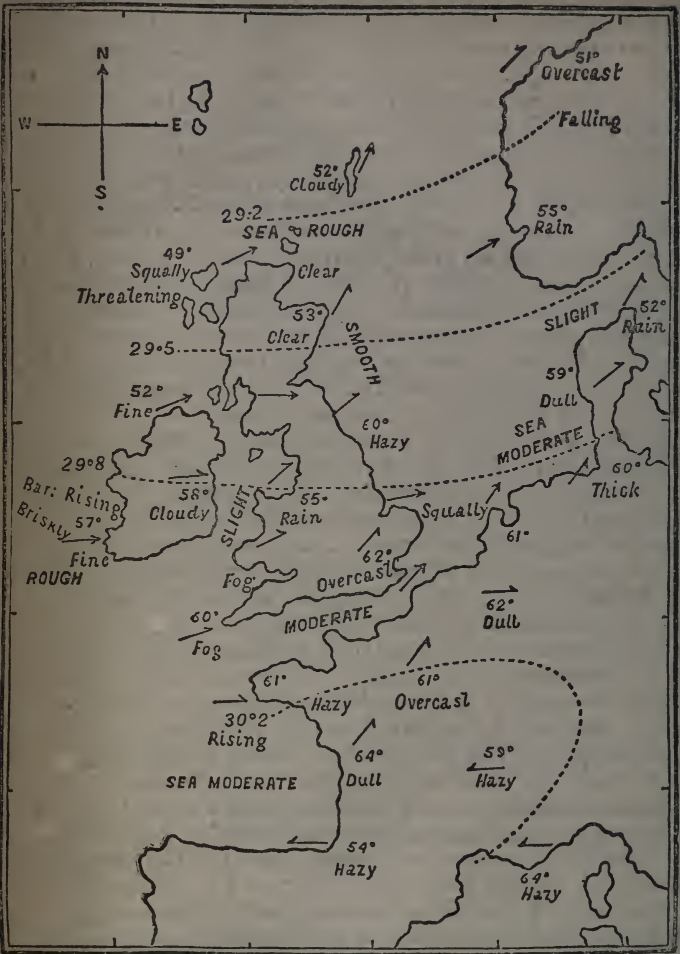
Meteorological observatories are provided with these instruments, and all nations worthy of the name of civilized co-operate with more or less efficiency in providing and endowing such establishments. They are placed in suitable localities, and communicate with each other, and with certain head-quarters, by means of the electric telegraph. One of these head-quarters is the Meteorological Office, at No. 116 Victoria Street, Westminster, S.W., which daily receives the results of the observations taken at about fifty stations on the British Islands and the Continent. The chief observations are made simultaneously—at 8 A.M.—and telegraphed in cypher to London, where they usually arrive before 10 A.M. As they come in they are marked down in their proper places upon a large chart, and when this chart is sufficiently completed, a condensed or abstract copy is made containing as much information as may be included in the small newspaper charts. This is copied mechanically on a reduced scale on a slab on which the outline chart has been already engraved. This engraving completed, casts are made in fusible metal with the black lines in relief, for printing with ordinary type, and the casts are set up with the ordinary newspaper types, and printed with the letterpress matter.

The engravings overleaf are taken from two of the newspaper weather charts for the dates of October 5th and 6th. They are enlarged and printed more clearly than the originals, with an explanation of signs at foot of the charts.

It will be observed that, in the chart for October 5th, an isobar of 29.2 runs up in a N.E. direction from between the Orkney and Shetland islands, crosses the North Sea, strikes the coast of Norway near Bergen, and then proceeds onwards towards Throndhjem. An isobar of 29.5 crosses Scotland, following very nearly the line of the Grampians, enters the North Sea about Aberdeen, and crosses to Christiansund; then runs up the Skager Rack and Christiania Fjord towards Christiania. Another isobar of 29.8 crosses Ireland through Connaught to Dublin, onward across England by Liverpool and the Humber, over the North Sea, and through Sleswig to the Baltic. These three are nearly parallel; but now we find another isobar—that of 30.2—taking quite a different course, by starting from the Bay of Biscay about Nantes; running on towards Paris and Strasbourg, and then bending sharp round, as though frightened by the Germans, and retreating to the Gulf of Lyons by an opposite course to that on which it started. On the following day all has changed; the northern isobars are running down south-eastwards instead of north-east, and are remarkably parallel. In the left-hand upper corner of this chart is a note that "*our west, north, and eastern coasts were warned yesterday.*" Why was this? It was mainly because the barometric *gradient* or incline was so steep. On the 5th there was one inch of difference between the Orkneys and the Bay of Biscay, or between Bergen and Paris, while the barometer was still falling in Norway and at the same moment rising in Ireland and France. On the following day these movements culminated in a gradient of 1.4—nearly one and a half inches—between Cornwall and the ancient capital of Norway.

What must follow from this condition of the atmosphere? Clearly a great flow or rush of air from the south towards the comparatively vacuous regions of the north. The gases of our atmosphere, like the waters of the ocean, are always struggling to find their level, and thereby the winds are produced. The air flows from all sides towards the lowest

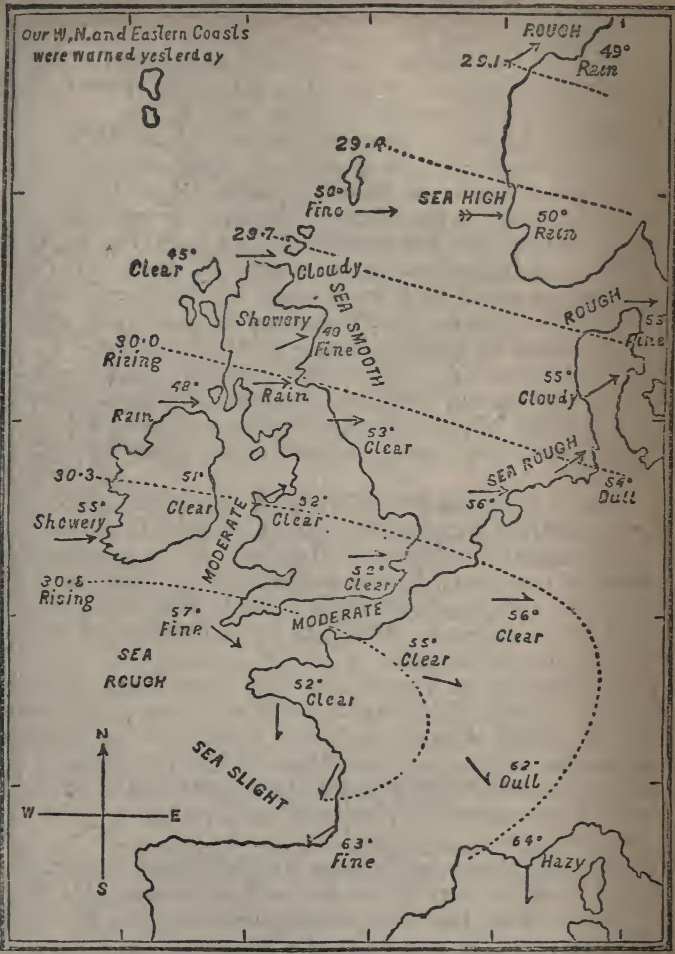
WEATHER CHART, OCTOBER 5, 1875.



EXPLANATION OF WEATHER CHART.

In these charts the state of the sea—whether "rough," "smooth," "moderate," "slight," etc., is marked in capital letters; and the state of the weather—as "clear," "dull," "cloudy," "showery," etc., in small letters. The direction of the wind is indicated by the arrows. Unlike the arrows of a vane, these do not point towards the direction from which the wind is coming, but are *flying* arrows represented as moving *with* the wind, and consequently pointing to *where the wind is going*. The force of the wind is represented in five degrees of strength. 1st. A *calm*, by a horizontal line and zero—thus o; 2nd. A *light wind*, by an arrow with one barb and no feathers ——→; 3rd. A *fresh to strong*

WEATHER CHART, OCTOBER 6, 1875.



breeze, by an arrow with two barbs and no feathers ——> ; 4th. A *gale*, by an arrow with two feathers >——> ; and 5th. A *violent gale*, by an arrow with four feathers >>——>. The temperature—in the shade—is marked in figures with a small circle to the right, indicating degrees—as 60°. These figures stand in the places where the observations are made. The other figures—usually with decimals, and placed at the end of the dotted lines—give the height of the barometer—the dotted line showing where this particular height remained the same at the time of observation. These dotted lines are called "isobars," *or equal weights*—the weight or over-head pressure of the atmosphere being the same all along the line.

isobar. But what, then, must be the course of the wind? Will it be in straight lines towards this point? If so, a strange conflict must result when all these currents meet from opposite directions. What will follow from this conflict? A skillful physicist can work out this problem mathematically, but we are not all mathematicians, some of us are not able to follow his formulæ, and, therefore, will do better by resorting to simple observation of other analogous and familiar phenomena. A funnel or any vessel with a hole in the bottom will answer our purpose. Let us fill such a vessel with water, then open the hole, and see what will be the course of the water when it is struggling to flow from all sides to the one point of vacuity. It will very soon establish a vortex or whirlpool, *i.e.*, the water instead of flowing directly by straight lines from the sides to the centre of the funnel, will take a roundabout, spiral course, and thus screw its way down the outlet of the funnel.

This is just what occurs when the air is rushing to fill a comparatively vacuous atmospheric space. It moves in a spiral; and in the Northern Hemisphere this spiral always turns in the same way, viz., in the opposite direction to the hands of a clock when flowing inwards, and *vice versâ*, or *with* the clock hands, when the air is overflowing from a centre of high pressure.

In the chart for October 5th both these cases are illustrated. North of Dublin there is a curvature of isobars and an inrush of winds towards a northward low pressure, or vacuous region; while south of Dublin the isobar tends sharply round a high-pressure focus, and the overflowing wind is correspondingly reversed in direction, as shown by the arrows.

The next chart, for October 6th, shows that the overflow has spread northwards as far as Dublin, and the high-pressure focus has also moved northwards. It follows from this that if you know the barometric gradient, and stand with your left hand to the region of low barometer and your right hand to that of the high barometer, the wind will blow against your back, *i.e.*, you will face the direction of the wind, or of those flying arrows on the chart. This interesting and important generalization is called "Buys Ballot's Law." In spite of the proverbial fickleness of the winds this simple law is rarely infringed, though it may require a slight modification of statement—inasmuch as the wind does not move in *circles* round the vacuous space, but in spirals, and thus it blows not quite square to the back, but rather obliquely, or a little on the right side. This is shown by the arrows in the charts, and is most strikingly displayed in the chart for October 6th, between the isobars of 30.3 and 30.5. To take, in Ireland, the position required by Buys Ballot's Law, one must have stood facing the east, and accordingly, the westerly wind would then blow upon one's back. In Paris, at the same moment, the position would be facing south-east, and the wind was curving round accordingly. Further south—at Bordeaux or the Pyrenees—the position becomes almost reversed, *i.e.*, facing south-west, and the wind is reversed in equal degree.

Here, then, on these days we had the chief conditions of wind and rain, a steep and increasing barometric gradient, and a flow over our islands of humid air from the south and west regions of the great Atlantic. Strong winds and heavy rains did follow accordingly; and the prophetic warnings of the Meteorological Office, which are conveyed by means of signals displayed on prominent parts of the coast, were fulfilled.

Mr. Scott, the Director of the Meteorological Office, tells us that "The degree of success that has attended our warnings in these islands, on the average of the last two years, has been that over 45 per cent have been followed by severe gales; and over 33 per cent in addition have been followed by wind too strong for fishing-boats and yachts, though in themselves not severe gales; this gives a total percentage of success of nearly 80."

In winter the movements of the air are more decided, and the changes are often so rapid that the warning sometimes comes too late. With increased means—*i.e.*, more money to cover additional work, and more stations—better results might be obtained. The United States expend 50,000*l.* a year in weather telegraphy, exclusive of salaries, while the United Kingdom only devotes 3,000*l.* a year to the same purpose. The difficulties on our side of the Atlantic are greater than on the American coasts, on account of the greater changeableness of our weather—mainly due to the more irregular distribution of land and water on this side. This, however, instead of discouraging national effort, should be regarded as a reason for increasing it. The greater the changes, the greater is the need for warnings, and the greater the difficulty the greater should be the effort. With our multitude of coastguard stations and naval men without employment, we ought to surpass all the world in such a work as this.

Those among our readers who are sufficiently interested in this subject to devote a little time to it, may make a very interesting weather scrap-book by cutting out the newspaper chart for each day, pasting it in a suitable album, and appending their own remarks on the weather at the date of publication, *i.e.* the day after the chart observations are made. Such an album would be far more interesting than the postage stamp and monogram albums that are so abundant.

Parents who desire their children to acquire habits of systematic observation, and to cultivate an intelligent interest in natural phenomena, will do well to supply such albums to their sons or daughters, and to hand over to them the daily paper for this purpose.

The Meteorological Office supplies by post copies of "Daily Weather Reports" to any subscriber who pays five shillings per quarter in advance; such subscriptions payable to Robt. H. Scott, Esq., Director Meteorological Office, 116 Victoria Street, Westminster, S.W.

These daily reports are printed on a large double sheet, on one half of which are four charts, representing separately the four records which are included in the one smaller newspaper chart—viz., those of the barometer, the thermometer, the rain-gauge, and the anemometer. On the other half of the sheet is a detailed separate tabular statement of the results of observations made at the following stations:

Haparanda
Hernösand
Stockholm
Wisby
Christiansund
Skudesnaes
Oxö(Christiansund)
Skagen (The Skaw)
Fanö
Cuxhaven
Sumburgh Head
Stornoway
Thurso
Wick
Nairn
Aberdeen
Leith
Shields
York
Scarborough
Nottingham
Ardrossan
Greencastle
Donaghadee
Kingstown
Holyhead
Liverpool
Valencia
Roche's Point
Pembroke
Portishead
Scilly
Plymouth
Hurst Castle
Dover
London
Oxford
Cambridge
Yarmouth
The Helder
Cape Griznez
Brest
L'Orient
Rochefort
Biarritz
Corunna
Brussels
Charleville
Paris
Lyons
Toulon

On Winds and Currents, from the Admiralty Physical Atlas.

In the Northern Hemisphere the effect of the veering of the wind on the barometer is according to the following law:

With East, South-east, and South winds, the barometer falls.

With South-west winds, the barometer ceases to fall and begins to rise.

With West, North-west, and North winds, the barometer rises.

With North-east winds, the barometer ceases to rise and begins to fall.

In the Northern Hemisphere the thermometer rises with East, South-east, and South winds; with a South-west wind it ceases to rise and begins to fall; it falls with West, North-west, and North winds; and with a North-east wind it ceases to fall and begins to rise.

THE CHEMISTRY OF BOG RECLAMATION.

The mode of proceeding for the reclamation of bog-land at Kylemore is first to remove the excess of water by "the big drain and the secondary drains," which must be cut deep enough to go right down to the gravel below. These are supplemented by the "sheep-drains," or surface-drains, which are about twenty inches wide at top, and narrow downwards to six inches at bottom. They run parallel to each other, with a space of about ten yards between, and cost one penny per six yards.

This first step having been made, the bog is left for two years, during which it drains, consolidates, and sinks somewhat. If the bog is deep, the turf, which has now become valuable by consolidation, should be cut.

After this it is left about two years longer, with the drains still open. Then the drains are cleared and deepened, and a wedge-shaped sod, too wide to reach the bottom, is rammed in so as to leave below it a permanent tubular covered drain, which is thus made without the aid of any tiles or other outside material. The drainage is now completed, and the surface prepared for the important operation of dressing with lime, which, as the people expressively say, "boils the bog," and converts it into a soil suitable for direct agricultural operations.

Potatoes and turnips may now be set in "lazy bed" ridges. Mr. Mitchell Henry says, "Good herbage will grow on the bog thus treated; but as much as possible should at once be put into root-crops, with farm-yard manure for potatoes and turnips. The more lime you give the better will be your crop; and treated thus there is no doubt that even during the first year land so reclaimed will yield remunerative crops." And further, that "after being broken up a second time the land materially improves, and becomes doubly valuable." Also that he has no doubt that "all bog-lands may be thus reclaimed, but it is up-hill work, and not remunerative to attempt the reclamation of bogs that are more than four feet in depth."

There is another and a simpler method of dealing with bogs—viz., setting them into narrow ridges; cutting broad trenches between the ridges; piling the turf cut out from these trenches into little heaps a few feet apart, burning them, and spreading the ashes over the ridges. This is rather largely practiced on the coast of Donegal, in conjunction with sea-weed manuring, and is prohibited in other parts of Ireland as prejudicial to the interests of the landlord.

We shall now proceed to the philosophy of these processes.

First, the drainage. Everybody in Ireland knows that the bog holds water like a sponge, and in such quantities that ordinary vegetation is rotted by the excess of moisture. There is good reason to believe that the ancient forests, which once occupied the sites of most of the Irish bogs, were in some cases destroyed by the rotting of their stems and roots in the excess of vegetable soil formed by generations upon generations of fallen leaves, which, in a humid climate like that of Ireland, could never become drained or air-dried.

But this is not all. There is rotting and rotting. When the rotting of vegetable matter goes on under certain conditions it is highly favorable to the growth of other vegetation, even of the vegetation of the same kind of plants as those supplying the rotting material. Thus, rotten and rotting straw is a good manure for wheat; and the modern scientific vine-grower carefully places the dressing of his vines about their roots, in order that they may rot, and supply the necessary salts for future growth. The same applies generally; rotting cabbage-leaves supply the best of manure for cabbages; rotting rhubarb-leaves for rhubarb; rose-leaves for rose-trees; and so on throughout the vegetable kingdom.

Why, then, should the bog-rotting be so exceptionally malignant? As I am not aware that any answer has been given to this question, I will venture upon one of my own. It appears to be mainly due to the excess of moisture preventing that slow combustion of vegetable carbon which occurs wherever vegetable matter is heaped together and *slightly* moistened. We see this going on in steaming dunghills; in hayricks that have been stacked when imperfectly dried; in the spontaneous combustion of damp cotton in the holds of ships, and in factories where cotton-waste has been carelessly heaped; and in cucumber-frames and the other "hot-beds" of the gardener.

In ordinary soils this combustion goes on more slowly, but no less effectively, than in these cases. In doing so it maintains a certain degree of warmth about the roots of the plants that grow there, and *gradually* sets free the soluble salts which the rotting vegetables contain, and supplies them to the growing plants as manure, at the same time forming the humus so essential to vegetation.

A great excess of water, such as soddens the bog, prevents this, and also carries away any small quantity of soluble nutritious salts the soil may contain. Thus, instead of being warmed and nourished by slight humidity, and consequent oxidation, the bog soil is chilled and starved by excess of water.

The absolute necessity of the first operation—that of drainage—is thus rendered obvious; and I suspect that the need of four years' rest, upon which Mr. MacAlister insists, is somehow connected with a certain degree of slow combustion that accompanies and partially causes the consolidation of the bog. I have not yet had an opportunity of testing this by inserting thermometers in bogs under different conditions, but hope to do so.

The liming next demands explanation. Mr. Henry says that "it leaves the soil sweetened by the neutralization of its acids."

In order to test this theory I have digested (*i.e.*, soaked) various samples of turf cut from Irish bogs in distilled water, filtered off the water, and examined it. I find that when this soaking has gone far enough to give the water a coloring similar to that which stands in ordinary bogs, the acidity is very decided—quite sufficiently so to justify this neutralization theory as a partial explanation. There is little reason to doubt that the lime is further effective in enriching the soil; or, in the case of pure bogs, that it forms the soil by disintegrating and decomposing the fibrous vegetable matter, and thus rendering it capable of assimilation by the crops.

Another effect which the lime must produce is the liberation of free ammonia from any fixed salts that may exist in the bog.

The bog-burning method of reclamation is easily explained. In the first place, the excessive vegetable encumbrance is reduced in quantity, and the remaining ashes supply the surface of the bog on which they rest with the non-volatile salts that originally existed in the burnt portions of the bog. In other words, they concentrate in a small space the salts that were formerly distributed too sparsely through the whole of the turf which was burnt.

As there are great differences in the composition of different bogs, especially in this matter of mineral ash, it is evident that the success of this method must be very variable, according to the locality.

On discussing this method with Mr. MacAlister (Mr. Henry's steward, under whose superintendence these reclamation works are carried out), he informed me that the bogs on the Kylemore estate yield a very small amount of ash—a mere impalpable powder that a light breath might blow away; that it was practically valueless, excepting from the turf taken at nearly the base of the bog. The ash I examined where the bog-burning is extensively practiced in Donegal, was quite different from this. The quantity was far greater, and its substance more granular and gritty. It, in fact, formed an important stratum, when spread over the surface of the ridges. These differences of composition may account for the differences of opinion and practice which prevail in different districts. It affords a far more rational explanation than the assumption that all such contradictions arise from local stupidities.

There is one evil, however, which is common to all bog-burning as compared with liming—it must waste the ammoniacal salts, as they are volatile, and are driven away into the air by the heat of combustion. Somebody may get them when the rain washes them down to the earth's surface again; but the burner himself obtains a very small share in this way.

We may therefore conclude that where lime is near at hand, bog-burning is a rude and wasteful, a viciously indolent mode of reclamation. It is only desirable where limestone is so distant that the expense of carriage renders lime practically unattainable, and where the bog itself is rich in mineral matter, and so deep and distant from a fuel demand, that it may be burned to waste without any practical sacrifice. Under such conditions it may be better to burn the bog than leave it in hopeless and worthless desolation.

I cannot conclude without again adverting to the importance of this subject, and affirming with the utmost emphasis, that the true Irish patriot is not the political orator, but he who by practical efforts, either as capitalist, laborer, or teacher, promotes the reclamation of the soil of Ireland, or otherwise develops the sadly neglected natural resources of the country.

With Mr. Mitchell Henry's permission I append to the above his own description of the results of his experiment, originally communicated in a letter to the *Times;* at the same time thanking him for his kind reception of a stranger at Kylemore Castle, and the facilities he afforded me for studying the subject on the spot.

"The interesting account you lately published of the extensive reclamations of His Grace the Duke of Sutherland, under the title of 'An Agricultural Experiment,' has been copied into very many newspapers, and must have afforded a welcome relief to thousands of readers glad to turn for a time from the terrible narratives that come to us from the east. If you will allow me, I should like to supplement your narrative by a rapid sketch of what has been done here during the last few years, on a much humbler scale, in the case of land similar, and some of it almost identical, with that in Sutherlandshire.

"The twelve *corps d'armée* under the Duke's command, in the shape of the twelve steam-engines and their ploughs, engaged in subduing the stubborn resistance of the unreclaimed wilds of Sutherlandshire, suggest to the mind the triumphs of great warriors, and fill us with admiration—not always excited by the details of great battle; but, as great battles can be fought seldom, and only by gigantic armies and at prodigious expense, so reclamation on such a scale is far beyond the opportunities or the means of most of us; while many may, perhaps, be encouraged to attempt work similar to that which has been successfully carried out here.

"And, first of all, a word as to the all-important matter of cost. Does it pay?

"Including farm-buildings and roads, the reclamations here have cost on an average 13*l.* an acre, which, at 5 per cent, means an annual rent-charge of 13*s.*, to which is to be added a sum of from 1*s.* to 3*s.*, the full annual value of the unreclaimed land. It is obvious that if we start with an outlay of 30*l.* *plus* the 1*s.* to 3*s.* of original rent, such an amount would usually be found prohibitory; but, on the other hand, excellent profits may be made if the expenditure is so kept down that the annual rent is not more than from 15*s.* to 18*s.* per acre. Before entering into further details; let me say that I claim no credit for originality in what has been done. The like has been effected on numerous properties in Ireland in bygone days, and is daily being carried out by the patient husbandman who year by year with his spade reclaims a little bit from the mountain side. And you must allow me emphatically to say that what has been done here economically and well would not have been done except for the prudence, patience, and thoughtful mind of my steward, Archibald MacAlister, a County Antrim man, descended from one of the race of Highland Catholic Scotch settlers, who have peopled the north of Ireland and added so much to its prosperity.

"The Pass of Kylemore, in which I live, is undoubtedly favorably situated for reclamation, for there is but little very deep bog, and there is abundance of limestone. In former ages it must have been an estuary of the sea, with a river flowing through it, now represented by a chain of lakes and the small rapid river Dowris. The subsoil is sand, gravel, and schist rock, with peat of various depths grown upon it. As by the elevation of the land the sea long ages ago was driven back, the mossy growth of peat commenced, followed by pine and yew trees, of which the trunks and roots are abundantly found; but, except over a space of about 400 acres, every tree that formerly clothed the hillsides has been cut down or has totally disappeared. The general result is that we have a pass several miles long, bounded on the north and south by a chain of rugged mountains of some 1500 or 1800 feet in height, while the east is blocked up by a picturesque chain running north and south, and separating the Joyce country from Connemara proper, the west being open to the Atlantic. The well-known Killery Bay, or Fiord, would, I doubt not, present an exact resemblance to Kylemore if the sea, which now flows up to its head, were driven out. There are miles of similar country in Ireland, waiting only for the industry of man, where, as here, there exist extensive stretches of undulating eskers, covered with heather growing on the light clay, with a basis of gravel or sand.

"A considerable difference exists between the reclamation of the flat parts, where the bog is pretty deep, and the hill-sides, where there is little or no bog. Yet it is to be remembered that bog is nothing more than vegetable matter in a state of partial decomposition, and holding water like a sponge. The first thing is to remove the water by drains, some of which—that is, the big drain and the secondary drains—must go right down to the gravel below; but the other drains—called sheep-drains—need not, and, indeed, must not be cut so deep. The drains are cut wedge-shape by what are called Scotch tools, which employ three men—two to cut and one to hook out the sods; and all that is requisite to form a permanent drain is to replace the wedge-shaped sod, and ram it down between the walls of the drain, where it consolidates and forms a tube which will remain open for an indefinite number of years. We have them here as good as new, made twenty-five years ago; and at Chat Moss, in Lancashire, they are much older. After land has been thus drained—but not too much drained, or it will become dry turf—the surface begins to sink; what was tumid settles down, and in the course of a few months the land itself becomes depressed on the surface and much consolidated. Next it is to be dug by spade-labor or ploughed. We use oxen largely for this purpose, and, strange to say, the best workers we find to be a cross with the Alderney, the result being a light, wiry little animal, which goes gayly over the ground, is easy to feed, and is very tractable. The oxen are trained by the old wooden neck-yoke; but, when well broken, work in collars, which seem more easy to them. Horses on very soft land work well in wooden pattens.

After the land has been broken up, a good dressing of lime is to be applied to it, and this, in the expressive language of the people here, 'boils the bog'—that is, the lime causes the vegetable matter, formerly half decomposed, to become converted into excellent manure. This leaves the soil sweetened by the neutralization of its acids, and in a condition pretty easily broken up by the chain-harrow; or, what is better still, by Randall's American revolving harrow.

"Good herbage will grow on bog thus treated, but as much as possible should at once be put into root-crops, with farmyard manure for potatoes and turnips. The more lime you give the better will be your crop, and, treated thus, there is no doubt that even during the first year, land so reclaimed will yield remunerative crops. People ask, 'But will not the whole thing go back to bog?' Of course it will if not kept under proper rotation, which we find to be one of five years—namely, roots followed by oats, laid down with clover and grass seed, which remains for two years. After being broken up a second time, the land materially improves and becomes doubly valuable. I have no doubt that all bog-lands may be thus reclaimed, but it is up-hill work and not remunerative to attempt the reclamation of bogs that are more than four feet in depth.

"And here I will make a remark as to the effects of drainage in a wet country. By no means does the whole effect result from raising the temperature of the soil; there is something else as important, and that is the supply of ammonia, brought down from the skies in the rain, which, with other fertilizing matter, is caught, detained, and absorbed in the soil. A well-drained field becomes, in fact, just like a water-meadow over which a river flows for a part of a year; and thus the very wetness of the climate may be made to reduce the supply of ammoniacal manures, so expensive to buy.

"The porous, well-drained soil carries quickly off the superfluous moisture, while the ammonia is absorbed by the roots and leaves of the plants. An excessive bill for ammoniacal manures has been the ruin of many a farmer; and our aim in Ireland should be to secure good crops by thorough drainage and constant stirring of the soil, without much outlay for concetrated manures. At the same time I ought to remark that we have grown excellent potatoes by using 5*l.* worth per acre of superphosphate and nitrate of soda in cases in which our farmyard manure has fallen short.

"The reclamation of mountain-land as distinguished from bog-land can best be illustrated by a record of what has been accomplished on two farms here. Three years ago the leases of two upland farms fell in, and I took them into my own hands. The first consists of 600 acres, one-half a nearly level flat of deepish bog running alongside the river, the other half moor heath, which with difficulty supported a few sheep and cattle.

"There had never been any buildings on this land, nor had a spade ever been put into it; and the tenant, being unable to pay his rent of 15*l.* a year for the 600 acres, was glad to give it up for a moderate consideration. The first thing accomplished was to fence and drain thoroughly as before described, and the best half of the land was then divided into forty-acre fields. Exactly now two years ago—on September 15th—a little cottage and a stable for a pair of horses and a pair of bullocks was completed and tenanted by two men and a boy. They ploughed all the week and came home on Saturdays to draw their supply of food and fodder for the ensuing seven days, thus approximating very nearly to the position of settlers in a new country. We limed all the land we could, manured part of it with sea-weed and part with the farm manure made by the horses and oxen which were at work, and cropped with roots such as turnips and potatoes. A good portion we sowed with oats out of the lea, but the most satisfactory crop we found to be rape and grasses mixed, for on the best of the land they form at once an excellent permanent pasture. We have now had two crops from this land; and I venture to say that the thirteen stacks of oats and hay gathered in in good condition, and the turnips and roots now growing, which are not excelled in the county Galway—except those of Lord Clancarty at Ballinasloe, who has grown 110 tons of turnips to the Irish acre, equal to upwards of 68 tons to the acre here—present a picture most gratifying and cheering in every way.

"The second farm, of 240 acres, which adjoins this, had a good building on it; but, having been let on lease at about 10s. an acre to a large grazier whose stock-in-trade was a horse, a saddle, and a pair of shears, had not been cultivated or improved.

"Similar proceedings on this farm have produced similar results; and, if now let in the market, I have no doubt that after two years of good treatment these farms would be let at 20s. an acre, and I do not despair of doubling this figure in the course of time.

"The exact weight of the turnip crop this season is, on raw bog, drained, limed, and cropped this year for the first time, 24 tons per acre; manure, seaweed. On land ploughed but not cropped, last year 23½ tons; mixed mineral manure. On land from which a crop of oats had previously been taken, 29 tons; manure, farmyard, with 3 cwt. per acre mineral manure.

"Last year my excellent steward, Mr. MacAlister, visited the Duke of Sutherland's reclamations in Scotland, and was kindly and hospitably received. He found the land and the procedure adopted almost identical, with the conviction that oxen and horses will suit us better at the present time than steam culture, chiefly on the score of economy. He also visited the Bridgewater Estate at Chat Moss, near Manchester, where so much has been done to bring the deep peat into cultivation, and he found the system that has been followed there for so many years to be like that described above, marl, however, being used in the place of lime."

At the time of my visit to Kylemore the hay crops were down and partly carried on the reclaimed bog-land above described. The contrast of its luxuriance with the dark and dreary desolation of the many estates I had seen during three summers' wanderings through Ireland added further proof of the infamy of the majority of Irish landlords, by showing what Ireland would have been had they done their duty.

AERIAL EXPLORATION OF THE ARCTIC REGIONS.

On our own hemisphere, and separated from our own coasts by only a few days' journey on our own element, there remains a blank circle of unexplored country above 800 miles in diameter. We have tried to cross it, and have not succeeded. Nothing further need be said in reply to those who ask, "Why should we start another Arctic Expedition?"

The records of previous attempts to penetrate this area of geographical mystery prove the existence of a formidable barrier of mountainous land, fringed by fjords or inlets, like those of Norway, some of which may be open, though much contracted northward, like the Vestfjord that lies between the Lofoden Islands and the mainland of Scandinavia. The majority evidently run inland like the ordinary Norwegian fjords or the Scotch firths, and terminate in land valleys that continue upwards to fjeld regions, or elevated humpy land which acts as a condenser to the vapor-laden air continually flowing towards the Pole from the warmer regions of the earth, and returning in lower streams when cooled. The vast quantities of water thus condensed fall upon these hills and table lands as snow crystals. What becomes of this everlasting deposit?

Unlike the water that rains on temperate hill-sides, it cannot all flow down to the sea as torrents and liquid rivers, but it does come down nevertheless, or long ere this it would have reached the highest clouds. It descends mainly as glaciers, which creep down slowly, but steadily and irresistibly, filling up the valleys on their way; and stretching outwards into the fjords and channels, which they block up with their cleft and chasmed crystalline angular masses that still creep outward to the sea until they float, and break off or "calve" as mountainous icebergs and smaller masses of ice.

These accumulations of ice thus *formed on land* constitute the chief obstructions that bar the channels and inlets fringing the unknown Polar area. The glacier fragments above described are cemented together in the winter time by the freezing of the water between them. An open frozen sea, pure and simple, instead of forming a barrier to arctic exploration, would supply a most desirable highway. It must not be supposed that, because the liquid ocean is ruffled by ripples, waves, and billows, a frozen sea would have a similar surface. The freezing of such a surface could only start at the calmest intervals, and the ice would shield the water from the action of the wave-making wind, and such a sea would become a charming skating rink, like the Gulf of Bothnia, the Swedish and Norwegian lakes, and certain fjords, which, in the winter time, become natural ice-paved highways, offering incomparable facilities for rapid locomotion. In spite of the darkness and the cold, winter is the traveling season in Sweden and Lapland. The distance that can be made in a given time in summer with a wheeled vehicle on well-made post roads can be covered in half the time in a *pulk* or reindeer sledge drawn over the frozen lakes. From Spitzbergen to the Pole would be an easy run of five or six days if nothing but a simply frozen sea stood between them.

This primary physical fact, that arctic navigators have not been stopped by a merely frozen sea, but by a combination of glacier fragments with the frozen water of bays, and creeks, and fjords, should be better understood than it is at present; for when it is understood, the popular and fallacious notion that the difficulties of arctic progress are merely dependent on latitude, and must therefore increase with latitude, explodes.

It is the physical configuration of the fringing zone of the arctic regions, not its mere latitude, that bars the way to the Pole.

I put this in italics because so much depends upon it—I may say that all depends upon it—for if this barrier can be scaled at any part we may come upon a region as easily traversed as that part of the Arctic Ocean lying between the North Cape and Spitzbergen, which is regularly navigated every summer by hardy Norsemen in little sailing sloops of 30 to 40 tons burden, and only six or eight pair of hands on board; or by overland traveling as easily as the Arctic winter journey between Tornea and Alten. This trip over the snow-covered mountains is done in five or six days, at the latter end of every November, by streams of visitors to the fair at Alten, in latitude 70°, 3½ degrees N. of the Arctic circle; its distance, 430 miles, is just about equal to that which stands between the North Pole and the northernmost reach of our previous Arctic expeditions. One or the other of the above-named conditions, or an enclosed frozen Polar ocean, is what probably exists beyond the broken fjord barrier hitherto explored; a continuation of such a barrier is, in fact, almost a physical impossibility; and therefore the Pole will be ultimately reached, not by a repetition of such weary struggles as those which ended in the very hasty retreat of our last expedition, but by a bound across about 400 miles of open or frozen Polar ocean, or a rapid sledge-run over snow-paved fields like those so merrily traversed in Arctic Norway by festive bonders and their families on their way to Yule-time dancing parties.

Reference to a map of the circumpolar regions, or, better, to a globe, will show that the continents of Europe, Asia, and America surround the Pole, and hang, as it were, downwards or southwards from a latitude of 70° and upwards. There is but one wide outlet for the accumulations of Polar ice, and that is between Norway and Greenland, with Iceland standing nearly midway. Davis's and Behring's Straits are the narrower openings; the first may be only a fjord, rather than an outlet. The ice-block, or crowding together and heaping up of the glacier fragments and bay ice, is thus explained.

Attempts of two kinds have been made to scale this icy barrier. Ships have sailed northwards, threading a dangerous course between the floating icebergs in the summer, and becoming fast bound in winter, when the narrow spaces of brackish water lying between these masses of land ice become frozen, and the "ice-foot" clinging to the shore stretches out seaward to meet that on the opposite side of the fjord or channel. The second method, usually adopted as supplementary to the first, is that of dragging sledges over these glacial accumulations. The pitiful rate of progress thus attainable is shown by the record of the last attempt, when Commander Markham achieved about one mile per day, and the labor of doing this was nearly fatal to his men. Any tourist who has crossed or ascended an Alpine glacier with only a knapsack to carry, can understand the difficulty of dragging a cartload of provisions, etc., over such accumulations of iceberg fragments and of sea-ice squeezed and crumbled up between them. It is evident that we must either find a natural breach in this Arctic barrier or devise some other means of scaling it.

The first of these efforts has been largely discussed by the advocates of rival routes. I will not go into this question at present, but only consider the alternative to all land routes and all water routes, viz.: that by the other available element—an aerial route—as proposed to be attempted in the new Arctic expedition projected by Commander Cheyne, and which he is determined to practically carry out, provided his own countrymen, or, failing them, others more worthy, will assist him with the necessary means of doing so.

To reach the Pole from the northernmost point already attained by our ships demands a journey of about 400 miles, the distance between London and Edinburgh. With a favorable wind, a balloon will do this in a few hours, On November 27, 1870, Captain Roher descended near Lysthuus, in Hitterdal (Norway), in the balloon "Ville d'Orleans," having made the journey from Paris in fifteen hours. The distance covered was about 900 miles, more than double the distance between the Pole and the accessible shores of Greenland.

On November 7, 1836, Messrs. Holland, Mason, and Green ascended from Vauxhall Gardens, at 1.30 P.M., with *a moderate breeze,* and descended eighteen hours afterwards "in the Duchy of Nassau, .about two leagues from the town of Weilburg," the distance in a direct line being about 500 miles. A similar journey to this would carry Commander Cheyne from his ship to the North Pole, or thereabouts, while a fresh breeze like that enjoyed by Captain Roher would, in the same time, carry him clear across the whole of the circumpolar area to the neighborhood of Spitzbergen, and two or three hours more of similar proceeding would land him in Siberia or Finland, or even on the shores of Arctic Norway, where he could take the Vadsö or Hammerfest packet to meet one of Wilson's liners at Trondhjem or Bergen, and thus get from the North Pole to London in ten days.

Lest any of my readers should think that I am writing this at random, I will supply the particulars. I have before me the "Norges Communicationer" for the present summer season of 1880. Twice every week a passenger excursion steam packet sails round the North Cape each way, calling at no less than twenty stations on this Arctic face of Europe to land and embark passengers and goods. By taking that which stops at Gjesvaer (an island near the foot of the North Cape) on Saturday, or that which starts from Hammerfest on Sunday morning, Trondhjem is reached on Thursday, and Wilson's liner, the "Tasso," starts on the same day for Hull, "average passage seventy hours." Thus Hammerfest, the northernmost town in the world, is now but eight days from London, including a day's stop at Tromsö, the capital of Lapland, which is about 3 degrees N. of the Arctic circle, and within a week of London. At Captain Roher's rate of traveling Tromsö would be but twenty-three hours from the Pole.

These figures are, of course, only stated as *possibilities* on the supposition that all the conditions should be favorable, but by no means as *probable.*

What, then, are the *probabilities* and the amount of risk that will attend an attempt to reach the Pole by an aerial route?

I have considered the subject carefully, and discussed it with many people; the result of such reflection and conversation is a conviction that the prevalent popular estimate of the dangers of Commander Cheyne's project extravagantly exaggerates them on almost all contingencies. I do not affirm that there is no risk, or that the attempt should be made with only our present practical knowledge of the subject, but I do venture to maintain that, after making proper preliminary practical investigations at home, a judiciously conducted aerostatic dash for the Pole will be far less dangerous than the African explorations of Livingstone, Stanley, and others that have been accomplished and are proposed. And further, that a long balloon journey starting in summer-time from Smith's Sound, or other suitable Arctic station, would be less dangerous than a corresponding one started from London; that it would involve less risk than was incurred by Messrs. Holland, Mason, and Green, when they traveled from Vauxhall Gardens to Nassau.

The three principal dangers attending such a balloon journey are: 1st. The variability of the wind. 2d. The risk of being blown out about the open ocean beyond the reach of land. 3d. The utter helplessness of the aeronau during all the hours of darkness. I will consider these seriatim in reference to Arctic ballooning *versus* Vauxhall or Crystal Palace ballooning.

As regards the first danger, Vauxhall and Sydenham are in a position of special disadvantage, and all the ideas we Englishmen may derive from our home ballooning experience must tend to exaggerate our common estimate of this danger, inasmuch as we are in the midst of the region of variable winds, and have a notoriously uncertain climate, due to this local exaggeration of the variability of atmospheric movements. If instead of lying between the latitudes of 50° and 60°, where the N.E. Polar winds just come in collision with the S.W. tropical currents, and thereby effect our national atmospheric stir-about, we were located between 10° and 30° (where the Canary Islands are, for example), our notions on the subject of balloon traveling would be curiously different. The steadily blowing trade-wind would long ere this have led us to establish balloon mails to Central and South America, and balloon passenger expresses for the benefit of fast-going people or luxurious victims of sea-sickness. To cross the Atlantic—three thousand miles—in forty-eight hours, would be attended with no other difficulty than the cost of the gas, and that of the return carriage of the empty balloon.

It is our exceptional meteorological position that has generated the popular expression "as uncertain as the wind." We are in the very centre of the region of meteorological uncertainties, and cannot go far, either northward or southward, without entering a zone of greater atmospheric regularity, where the direction of the wind at a given season may be predicted with more reliability than at home. The atmospheric movements in the Arctic regions appear to be remarkably regular and gentle during the summer and winter months, and irregular and boisterous in spring and autumn. A warm upper current flows from the tropics towards the Pole, and a cold lower one from the Arctic circle towards the equator. Commander Cheyne, who has practical experience of these Arctic expeditions, and has kept an elaborate log of the wind, etc., which he has shown me, believes that, by the aid of pilot balloons to indicate the currents at various heights, and by availing himself of these currents, he may reach the Pole and return to his ship, or so near as to be able to reach it by traveling over the ice in light sledges that will be carried for that purpose. In making any estimate of the risk of Arctic aerostation, we must banish from our minds the preconceptions induced by our British experience of the uncertainties of the wind, and only consider the atmospheric actualities of the Polar regions, so far as we know them.

Let us now consider the second danger, viz., that of being blown out to sea and there remaining until the leakage of gas has destroyed the ascending power of the balloon, or till the stock of food is consumed. A glance at a map of the world will show how much smaller is the danger to the aeronaut who starts from the head of Baffin's Bay than that which was incurred by those who started from Vauxhall in the Nassau balloon, or by Captain Roher, who started from Paris. Both of these had the whole breadth of the Atlantic on the W. and S.W., and the North Sea and Arctic Ocean N, and N.E. The Arctic balloon, starting from Smith's Sound or thereabouts, with a wind from the South (and without such a wind the start would not, of course, be made), would, if the wind continued in the same direction, reach the Pole in a few hours; in seven or eight hours at Roher's speed; in fourteen or fifteen hours at the average rate made by the Nassau balloon in a "moderate breeze." Now look again at the map and see what surrounds them. Simply the continents of Europe, Asia, and America, by which the circumpolar area is nearly land-locked, with only two outlets, that between Norway and Greenland on one side, and the narrow channel of Behring's Straits on the other. The wider of these is broken by Spitzbergen and Iceland, both inhabited islands, where a balloon may descend and the aeronauts be hospitably received. Taking the 360 degrees of the zone between the 70th parallel of latitude and the Arctic circle, 320 are land-locked and only 40 open to the sea; therefore the chances of coming upon land at *any one* part of this zone is as 320 to 40; but with a choice of points for descent such as the aeronauts would have unless the wind blew precisely down the axis of the opening, the chances would be far greater. If the wind continued as at starting, they would be blown to Finland; a westerly deflection would land them in Siberia, easterly in Norway; a strong E. wind at the later stage of the trip would blow them back to Greenland.

In all the above I have supposed the aeronauts to be quite helpless, merely drifting at random with that portion of the atmosphere in which they happened to be immersed. This, however, need not be the case. Within certain limits they have a choice of winds, owing to the prevalence of upper and lower currents blowing in different and even in opposite directions. Suppose, for example, they find themselves N. of Spitzbergen, where "Parry's furthest" is marked on some of our maps, and that the wind is from the N.E., blowing them towards the Atlantic opening. They would then ascend or descend in search of a due N. or N. by W. wind that would blow them to Norway, or W.N.W. to Finland, or N.W. to Siberia, or due E. back to Greenland, from whence they might rejoin their ships. One or other of these would almost certainly be found. A little may be done in steering a balloon, but so very little that small reliance should be placed upon it. Only in a very light wind would it have a sensible effect, though in case of a "near shave" between landing, say at the Lofodens or

Iceland, and being blown out to sea, it might just save them.

As already stated, Commander Cheyne believes in the possibility of returning to the ship, and bases his belief on the experiments he made from winter quarters in Northumberland Sound, where he inflated four balloons, attached to them proportionately different weights, and sent them up simultaneously. They were borne by diverse currents of air in *four different directions according to the different altitudes*, viz., N.W., N.E., S.E., and S.W., "thus proving that in this case balloons could be sent in any required direction by ascending to the requisite altitude. The war balloon experiments at Woolwich afford a practical confirmation of this important feature in aeorstation." Cheyne proposes that one at least of the three balloons shall be a rover to cross the unknown area, and has been called a madman for suggesting this merely as an alternative or secondary route. I am still more lunatic, for I strongly hold the opinion that the easiest way for him to return to his ship will be to drift rapidly across to the first available inhabited land, thence come to England, and sail in another ship to rejoin his messmates; carrying with him his bird's-eye chart, that will demonstrate once for all the possibility or impossibility of circumnavigating Greenland, or of sailing, or sledging, or walking to the Pole.

The worst dilemma would be that presented by a dead calm, and it is not improbable that around the Pole there may be a region of calms similar to that about the Equator. Then the feather-paddle or other locomotive device worked by man-power would be indispensable. Better data than we at present possess are needed in order to tell accurately what may thus be done. Putting various estimates one against the other, it appears likely that five miles an hour may be made. Taking turn and turn about, two or three aeronauts could thus travel fully 100 miles per day, and return from the Pole to the ship in less than five days.

Or take the improbable case of a circular wind blowing round the Pole, as some have imagined. This would simply demand the working of the paddle always northwards in going to the Pole, and always southwards in returning. The resultant would be a spiral course winding inwards in the first case, and outwards in the second. The northward or southward progress would be just the same as in a calm if the wind were truly concentric to the Pole. Some rough approximation to such currents may exist, and might be dealt with on this principle.

Let us now consider the third danger, that of the darkness. The seriousness of this may be inferred from the following description of the journey of the Nassau balloon, published at the time: "It seemed to the aeronauts as if they were cleaving their way through an interminable mass of black marble in which they were imbedded, and which, solid a few inches before them, seemed to soften as they approached in order to admit them still further within its cold and dusky enclosure. In this way they proceeded blindly, as it may well be called, until about 3.30 A.M., when in the midst of the impenetrable darkness and profound stillness an unusual explosion issued from the machine above, followed by a violent rustling of the silk, and all the signs which might be supposed to accompany the bursting of the balloon. The car was violently shaken. A second and a third explosion followed in quick succession. The danger seemed immediate, when suddenly the balloon recovered her usual form and stillness. These alarming symptoms seemed to have been produced by collapsing of the balloon under the diminished temperature of the upper regions after sunset, and the silk forming into folds under the netting. Now, when the guide rope informed the voyagers that the balloon was too near the earth, ballast was thrown out, and the balloon rising rapidly into a thinner air experienced a diminution of pressure, and consequent expansion of the gas.

"The cold during the night ranged from a few degrees below to the freezing point. As morning advanced the rushing of waters was heard, and so little were the aeronauts aware of the course which they had been pursuing during the night, that they supposed themselves to have been thrown back upon the shores of the German Ocean, or about to enter the Baltic, whereas they were actually over the Rhine, not far from Coblentz."

All this blind drifting for hours, during which the balloon may be carried out to sea, and opportunities of safe descent may be lost, is averted in an Arctic balloon voyage, which would be made in the summer, when the sun never sets. There need be no break in the survey of the ground passed over, no difficulty in pricking upon a chart the course taken and the present position at any moment. With an horizon of 50 to 100 miles' radius the approach of such a danger as drifting to the open ocean would be perceived in ample time for descent, and as a glance at the map will show, this danger cannot occur until reaching the latitudes of inhabited regions.

The Arctic aeronauts will have another great advantage over those who ascend from any part of England. They can freely avail themselves of Mr. Green's simple but most important practical invention—the drag-rope. This is a long and rather heavy rope trailing on the ground. It performs two important functions. First, it checks the progress of the balloon, causing it to move less rapidly than the air in which it is immersed. The aeronaut thus gets a slight breeze equivalent to the difference between the velocity of the wind and that of the balloon's progress. He may use this as a fulcrum to effect a modicum of steerage.

The second and still more important use of the drag-rope is the very great economy of ballast it achieves. Suppose the rope to be 1000 feet long, its weight equal to 1 lb. for every ten feet, and the balloon to have an ascending power of 50 lbs. It is evident that under these conditions the balloon will retain a constant elevation of 500 feet above the ground below it, and that 500 feet of rope will trail upon the ground. Thus, if a mountain is reached no ballast need be thrown away in order to clear the summit, as the balloon will always lift its 500 feet of rope, and thus always rise with the up-slope and descend with the down-slope of hill and dale. The full use of this simple and valuable adjunct to aerial traveling is prevented in such a country as ours by the damage it might do below, and the temptation it affords to mischievous idiots near whom it may pass.

In the course of many conversations with various people on this subject I have been surprised at the number of educated men and women who have anticipated with something like a shudder the terrible cold to which the poor aeronauts will be exposed.

This popular delusion which pictures the Arctic regions as the abode of perpetual freezing, is so prevalent and general, that some explanation is demanded.

The special characteristic of Arctic climate is a cold and long winter and a short and *hot summer*. The winter is intensely cold simply because the sun never shines, and the summer is very hot because the sun is always above the horizon, and, unless hidden by clouds or mist, is continually shining. The summer heat of Siberia is intense, and the vegetable proportionately luxuriant. I have walked over a few thousand miles in the sunny South, but never was more oppressed with the heat than in walking up the Tromsdal to visit an encampment of Laplanders in the summer of 1856.

On the 17th July I noted the temperature on board the steam packet when we were about three degrees north of the Arctic circle. It stood at 77° well shaded in a saloon under the deck; it was 92° in the "rök lugar," a little smoking saloon built on deck; and 108° in the sun on deck. This was out at sea, where the heat was less oppressive than on shore. The summers of Arctic Norway are very variable on account of the occasional prevalence of misty weather. The balloon would be above much of the mist, and would probably enjoy a more equable temperature during the twenty-four hours than in any part of the world where the sun sets at night.

I am aware that the above is not in accordance with the experience of the Arctic explorers who have summered in such places as Smith's Sound. I am now about to perpetrate something like a heresy by maintaining that the summer climate there experienced by these explorers is quite exceptional, is not due to the latitude, but to causes that have hitherto escaped the notice of the explorers themselves and of physical geographers generally. The following explanation will probably render my view of this subject intelligible:

As already stated, the barrier fringe that has stopped the progress of Arctic explorers is a broken mountainous shore down which is pouring a multitude of glaciers into the sea. The ice of these glaciers is, of course, fresh-water ice. Now, we know that when ice is mixed with salt water we obtain what is called "a freezing mixture"—a reduction of temperature far below the freezing point, due to the absorption of heat by the liquefaction of the ice. Thus the heat of the continuously shining summer sun *at this particular part of the Arctic region* is continuously absorbed by this powerful action, and a severity quite exceptional is thereby produced Every observant tourist who has crossed an Alpine glacier on a hot summer day has felt the sudden change of climate that he encounters on stepping from *terra firma* on to the ice, and in which he remains immersed as long as he is on the glacier. How much greater must be this depression of temperature where the glacier ice is broken up and is floating in sea-water, to produce a vast area of freezing mixture, which would speedily bring the hottest blasts from the Sahara down to many degrees below the freezing point.

A similar cause retards the *beginning* of summer in Arctic Norway and in Finland and Siberia. So long as the winter snow remains unmelted, *i.e.*, till about the middle or end of June, the air is kept cold, all the solar heat being expended in the work of thawing. This work finished, then the warming power of a non-setting sun becomes evident, and the continuously accumulating heat of his rays displays its remarkable effect on vegetable life, and everything capable of being warmed. These peculiarities of Arctic climate must become exaggerated as the Pole is approached, the winter cold still more intense, and the accumulation of summer heat still greater. In the neighborhood of the North Cape, where these contrasts astonish English visitors, where inland summer traveling becomes intolerable on account of the clouds of mosquitoes, the continuous sunshine only lasts from May 11 to August 1. At the North Pole the sun would visibly remain above the horizon during about seven months—from the first week in March to the first week in October (this includes the effect of refraction and the prolonged summer of the northern hemisphere due to the eccentricity of the earth's orbit).

This continuance of sunshine, in spite of the moderate altitude of the solar orb, may produce a very genial summer climate at the Pole. I say "may," because mere latitude is only one of the elements of climate, especially in high latitudes. Very much depends upon surface configuration and the distribution of land and water. The region in which our Arctic expedition ships have been ice-bound combines all the most unfavorable conditions of Arctic summer climate. It is extremely improbable that those conditions are maintained all the way to the Pole. We know the configuration of Arctic Europe and Arctic Asia, that they are masses of land spreading out northward round the Arctic circle and narrowing southward to angular terminations. The southward configuration and northward outspreading of North America are the same, but we cannot follow the northern portion to its boundary as we may that of Europe and Asia, both of which terminate in an Arctic Ocean. Greenland is remarkably like Scandinavia; Davis's Strait, Baffin's Bay, and Smith's Sound corresponding with the Baltic and the Gulf of Bothnia. The deep fjords of Greenland, like those of Scandinavia, are on its western side, and the present condition of Greenland corresponds to that of Norway during the milder period of the last glacial epoch. If the analogy is maintained a little further north than our explorers have yet reached we must come upon a Polar sea, just as we come upon the White Sea and the open Arctic Ocean if we simply travel between 400 and 500 miles due north from the head of the frozen Gulf of Bothnia.

Such a sea, if unencumbered with land ice, will supply the most favorable conditions for a genial arctic summer, especially if it be dotted with islands of moderate elevation, which the analogies of the known surroundings render so very probable. Such islands may be inhabited by people who cannot reach us on account of the barrier wall that has hitherto prevented us from discovering them. Some have even supposed that a Norwegian colony is there imprisoned. Certainly the early colonists of Greenland have disappeared, and their disappearance remains unexplained. They may have wandered northwards, mingled with the Esquimaux, and have left descendants in this unknown world. If any of Franklin's crew crawled far enough they may still be with them, unable to return.

In reference to these possibilities it should be noted that a barrier fringe of mountainous land like that of Greenland and arctic America would act as a condensing ground upon the warm air flowing from the south, and would there accumulate the heavy snows and consequent glaciers, just as our western hills take so much of the rain from the vapor-laden winds of the Atlantic. The snowfall immediately round the Pole would thus be moderated, and the summer begin so much earlier.

I have already referred to the physical resemblances of Baffin's Bay, Smith's Sound, etc., to the Baltic, the Gulf of Bothnia, and Gulf of Finland. These are frozen every winter, but the Arctic Ocean due north of them is open all the winter, and every winter. The hardy Norse fishermen are gathering their chief harvest of cod fish in the open sea around and beyond the North Cape, Nordkyn, etc., at the very time when the Russian fleet is hopelessly frozen up in the Gulf of Finland. But how far due north of this frozen Baltic are these open-sea fishing banks? More than 14 degrees—more than double the distance that lies between the winter quarters of some of our ships in Smith's Sound and the Pole itself. This proves how greatly physical configuration and oceanic communication may oppose the climatic influences of mere latitude. If the analogy between Baffin's Bay and the Baltic is complete, a Polar sea will be found that is open in the summer at least.

On the other hand, it may be that ranges of mountains covered with perpetual snow, and valleys piled up with huge glacial accumulations, extend all the way to the Pole, and thus give to our globe an arctic ice-cap like that displayed on the planet Mars. This, however, is very improbable, for, if it were the case, we ought to find a circumpolar ice-wall like that of the antarctic regions; the Arctic Ocean beyond the North Cape should be crowded with icebergs instead of being open and iceless all the year round.

With such a configuration the ice-wall should reach Spitzbergen and stretch across to Nova Zembla; but, instead of this, we have there such an open stretch of arctic water, that in the summer of 1876 Captain Kjelsen, of Tromsö, sailed in a whaler to lat. 81° 30′ without sighting ice. He was then but 510 geographical miles from the Pole, with open sea right away to his north horizon, and nobody can say how much farther.

These problems may all be solved by the proposed expedition. The men are ready and willing; one volunteer has even promised 1000*l.* on condition that he shall be allowed to have a seat in one of the balloons. All that is wanted are the necessary funds, and the amount required is but a small fraction of what is annually expended at our race-courses upon villainous concoctions of carbonic acid and methylated cider bearing the name of "champagne."

Arrangements are being made to start next May, but in the meantime many preliminary experiments are required. One of these, concerning which I have been boring Commander Cheyne and the committee, is a thorough and practical trial of the staying properties of hydrogen gas when confined in given silken or other fabrics saturated with given varnishes. We are still ignorant on this fundamental point. We know something about coal-gas, but little or nothing of the hydrogen, such as may be used in the foregoing expedition. Its exosmosis, as proved by Graham, depends upon its adhesion to the surface of the substance confining it. Every gas has its own speciality in this respect, and a membrane that confines a hydrocarbon like coal-gas may be very unsuitable for pure hydrogen, or *vice versâ*. Hydrogen passes through hard steel, carbonic oxide through red-hot iron plates, and so on with other gases. They are guilty of most improbable proceedings in the matter of penetrating apparently impenetrable substances.

The safety of the aeronauts and the success of the aerial exploration primarily depends upon the length of time that the balloons can be kept afloat in the air.

A sort of humanitarian cry ha sbeen raised against this expedition, on the ground that unnaturally good people (of whom we now meet so many) should not be guilty of aiding and abetting a scheme that may cause the sacrifice of human life. These kind friends may be assured that, in spite of their scruples, the attempt will be made by men who share none of their fears, unless the preliminary experiments prove that a balloon cannot be kept up long enough. Therefore the best way to save their lives is to subscribe *at once* for the preliminary expense of making these trials, which will either discover means of traveling safely, or demonstrate the impossibility of such ballooning altogether. Such experiments will have considerable scientific value in themselves, and may solve other problems besides those of arctic exploration.

Why not apply balloons to African exploration or the crossing of Australia? The only reply to this is that we know too little of the practical possibilities of such a method of traveling when thus applied. Hitherto the balloon has only been a sensational toy. We know well enough that it cannot be steered in a predetermined *line*, *i.e.*, from one *point* to another given *point*, but this is quite a different problem from sailing over a given *surface of considerable area*. This can be done to a certain extent, but we want to know definitely to what extent, and what are the limits of reliability and safety. With this knowledge, and its application by the brave and skillful men who are so eager to start, the solution of the Polar mystery assumes a new and far more hopeful phase than it has ever before presented.

THE ANGLO-AMERICAN ARCTIC EXPEDITION.

Commander Cheyne has gone to America to seek the modest equipment that his own countrymen are unable to supply. He proposes now that his expedition shall be "Anglo-American." I have been asked to join an arctic council, to coöperate on this side, and have refused on anti-patriotic grounds. As a member of the former arctic committee, I was so much disgusted with the parsimony of our millionaires and the anti-geographical conduct of the Savile Row Mutual Admiration Society, that I heartily wish that in this matter our American grandchildren may "lick the Britishers quite complete." It will do us much good.

My views, expressed in the "Gentleman's Magazine" of July 1880, and repeated above, remain unchanged, except in the direction of confirmation and development. I still believe that an enthusiastic, practically trained, sturdy arctic veteran, who has endured hardship both at home and abroad, whose craving eagerness to reach the Pole amounts to a positive monomonia, who lives for this object alone, and is ready to die for it, who will work at it purely for the work's sake—will be the right man in the right place when at the head of a modestly but efficiently equipped Polar expedition, especially if Lieutenant Schwatka is his second in command.

They will not require luxurious saloons, nor many cases of champagne; they will care but little for amateur theatricals; they will follow the naval traditions of the old British "sea-dogs" rather than those of our modern naval lap-dogs, and will not turn back after a first struggle with the cruel arctic ice, even though they should suppose it to be "paleocrystic."

MR. WALTER POWELL.

Scientific aerostation has lost its most promising expert by the untimely death of Walter Powell. He was not a mere sensational ballooner, nor one of those dreamers who imagine they can invent flying machines, or steer balloons against the wind by mysterious electrical devices or by mechanical paddles, fan-wheels, or rudders.

He perfectly understood that a balloon is at the mercy of atmospheric currents and must drift with them, but nevertheless he regarded it as a most promising instrument for geographical research. I had a long conference with him on the subject in August last, when he told me that the main objects of the ascents he had already made, and should be making for some little time forward, were the acquisition of practical skill, and of further knowledge of atmospheric currents; after which he should make a dash at the Atlantic with the intent of crossing to America.

On my part, I repeated with further argument what I have already urged on page 113 of the "Gentleman's Magazine" for July, 1880, viz., the primary necessity of systematic experimental investigation of the rate of exosmosis (oozing out) of the gas from balloons made of different materials and variously varnished.

Professor Graham demonstrated that this molecular permeation of gases and liquids through membranes mechanically air-tight, depends upon the adhesive affinities of particular solids for other particular fluids, and these affinities vary immensely, their variations depending on chemical differences rather than upon mechanical impermeability. My project to attach captive balloons of small size to the roof of the Polytechnic Institution, holding them by a steelyard that should indicate the pull due to their ascending power, and the rate of its decline according to the composition of the membrane, was heartily approved by Mr. Powell, and, had the Polytechnic survived, would have been carried out, as it would have served the double purpose of scientific investigation and of sensational advertisement for the outside public.

If the aeronaut were quite clear on this point—could calculate accurately how long his balloon would float—he might venture with deliberate calculation on journeys that without such knowledge are mere exploits of blind daring.

The varnishes at present used are all permeable by hydrogen gas and hydrocarbon coal-gas, as might be expected, *à priori*, from the fact that they are themselves solid hydrocarbons, soluble in other liquid or gaseous hydrocarbons. Nothing, as far as I can learn, has yet been done with *silicic or boracic varnishes,** which are theoretically impermeable by hydrogen and its carbon compounds; but whether they are practically so under ballooning conditions, and can be made sufficiently pliable and continuous, are questions only to be solved by practical experiments of the kind above named. Now that the best man for making these experiments is gone, somebody else should undertake them. Unfortunately, they must of necessity be rather expensive.

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* Since the above was written I have made some experiments with a solution of shellac in borax (obtained by long boiling), and hereby claim the invention of its application to this purpose, in order to prevent anybody from patenting it. I shall not do so myself.

THE LIMITS OF OUR COAL SUPPLY.*

ESTIMATING the actual consumption of coal for home use in Great Britain at 110 millions of tons per annum, a rise of eight shillings per ton to consumers is equivalent to a tax of 44 millions per annum. These are the figures taken by Sir William Armstrong in his address at Newcastle last February. As the recent abnormal rise in the value of coal has amounted to more than this, consumers have been paying at some periods above a million per week as premium on fuel, even after making fair deduction for the rise of price necessarily due to the diminishing value of gold.

Are we, the consumers of coal, to write off all this as a dead loss, or have we gained any immediate or prospective advantage that may be deducted from the bad side of the account? I suspect that we shall gain sufficient to ultimately balance the loss, and, even after that, to leave something on the profit side.

The abundance of our fuel has engendered a shameful wastefulness that is curiously blind and inconsistent. As a typical example of this inconsistency, I may mention a characteristic incident. A party of young people were sitting at supper in the house of a colliery manager. Among them was the vicar of the parish, a very jovial and genial man, but most earnest withal in his vocation. Jokes and banterings were freely flung across the table, and no one enjoyed the fun more heartily than the vicar; but presently one unwary youth threw a fragment of bread-crust at his opposite neighbor, and thus provoked retaliation. The countenance of the vicar suddenly changed, and in stern clerical tones he rebuked the wickedness of thus wasting the bounties of the Almighty. A general silence followed, and a general sense of guilt prevailed among the revellers. At the same time, and in the same room, a blazing fire, in an ill-constructed open fire-place, was glaring reproachfully at all the guests, but no one heeded the immeasurably greater and utterly irreparable waste that was there proceeding. To every unit of heat that was fully utilized in warming the room, there were eight or nine passing up the chimney to waste their energies upon the senseless clouds and boundless outer atmosphere. A large proportion of the vicar's parishioners are colliers, in whose cottages huge fires blaze most wastefully all day, and are left to burn all night to save the trouble of re-lighting. The vicar diligently visits these cottages, and freely admonishes where he deems it necessary; yet he sees in this general waste of coal no corresponding sinfulness to that of wasting bread. Why is he so blind in one direction, while his moral vision is so microscopic in the other? Why are nearly all Englishmen and Englishwomen as inconsistent as the vicar in this respect?

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* Written during the coal famine of 1872–73.

There are doubtless several combining reasons for this, but I suspect that the principal one is the profound impression which we have inherited from the experience and traditions of the horrors of bread-famine. A score of proverbs express the important practical truth that we rarely appreciate any of our customary blessings until we have tasted the misery of losing them. Englishmen have tasted the consequences of approximate exhaustion of the national grain store, but have never been near to the exhaustion of the national supply of coal.

I therefore maintain most seriously that we need a severe coal famine, and if all the colliers of the United Kingdom were to combine for a simultaneous winter strike of about three or six months' duration, they might justly be regarded as unconscious patriotic martyrs, like soldiers slain upon a battle-field. The evils of such a thorough famine would be very sharp, and proportionally beneficent, but only temporary; there would not be time enough for manufacturing rivals to sink pits, and at once erect competing iron-works; but the whole world would partake of our calamity, and the attention of all mankind would be aroused to the sinfulness of wasting coal. Six months of compulsory wood and peat fuel, with total stoppage of iron supplies, would convince the people of these islands that waste of coal is even more sinful than waste of bread,—would lead us to reflect on the fact that our stock of coal is a definite and limited quantity that was placed in the present storehouse long before human beings came upon the earth; that every ton of coal that is wasted is lost for ever, and cannot be replaced by any human effort, while bread is a product of human industry, and *its* waste may be replaced by additional human labor; that the sin of bread-wasting does admit of agricultural atonement, while there is no form of practical repentance that can positively and directly replace a hundredweight of wasted coal.

Nothing short of the practical and impressive lesson of bitter want is likely to drive from our households that wretched fetish of British adoration, the open "Englishman's fireside." Reason seems powerless against the superstition of this form of fire-worship. Tell one of the idolaters that his household god is wasteful and extravagant, that five-sixths of the heat from his coal goes up the chimney, and he replies, "I don't care if it does; I can afford to pay for it. I like to *see* the fire, and have the right to waste what is my own." Tell him that healthful ventilation is impossible while the lower part of a room opens widely into a heated shaft, that forces currents of cold air through doors and window leakages, which unite to form a perpetual chilbrain stratum on the floor, and leaves all above the mantel-piece comparatively stagnant. Tell him that no such things as "draughts" should exist in a properly warmed and ventilated house, and that even with a thermometer at zero outside, every part of a well-ordered apartment should be equally habitable, instead of merely a semicircle about the hearth of the fire-worshiper; he shuts his ears, locks up his understanding, because his grandfather and grandmother believed that the open-mouthed chimney was the one and only true English means of ventilation.

But suppose we were to say, "You love a cheerful blaze, can afford to pay for it, and therefore care not how much coal you waste in obtaining it. We also love a cheerful blaze, but have a great aversion to coal-smoke and tarry vapors; and we find that we can make a beautiful fire, quite inoffensive even in the middle of the room, provided we feed it with stale quartern loaves. We know that such fuel is expensive, but can afford to pay for it, and choose to do so." Would he not be shocked at the sight of the blazing loaves, if this extravagance were carried out?

This popular inconsistency of disregarding the waste of a valuable and necessary commodity, of which the supply is limited and unrenewable, while we have such proper horror of wilfully wasting another similar commodity which can be annually replaced as long as man remains in living contact with the earth, will gradually pass away when rational attention is directed to the subject. If the recent very mild suggestion of a coal-famine does something towards placing coal on a similar pedestal of popular veneration to that which is held by the "staff of life," the million a week that it has cost the coal consumer will have been profitably invested.

Many who were formerly deaf to the exhortations of fuel economists are now beginning to listen. "*Forty shillings per ton*" has acted like an incantation upon the spirit of Count Rumford. After an oblivion of more than eighty years, his practical lessons have again sprung up among us. Some are already inquiring how he managed to roast 112 lbs. of beef at the Foundling Hospital with 22 lbs. of coal, and to use the residual heat for cooking the potatoes, and why it is that with all our boasted progress we do not now in the latter third of the nineteenth century, repeat that which he did in the eighteenth.

The fact that the consumption of coal in London during the first four months of 1873 has, in spite of increasing population, amounted to 49,707 tons less than the corresponding period of 1872, shows that some feeble attempts have been made to economize the domestic consumption of fuel. One very useful result of the recent scarcity of coal has been the awakening of a considerable amount of general interest in the work of stock-taking, a tedious process which improvident people are too apt to skirk, but which is quite indispensable to sound business proceedings, either of individuals or nations.

There are many discrepancies in the estimates that have been made of the total available quantity of British coal. The speculative nature of some of the data renders this inevitable, but all authorities appear to agree on one point, viz., that the amount of our supplies will not be determined by the actual total quantity of coal under our feet, but by the possibilities of reaching it. This is doubtless correct, but how will these possibilities be limited, and what is the extent or range of the limit? On both these points I venture to disagree with the eminent men who have so ably discussed this question. First, as regards the nature of the limit or barrier that will stop our further progress in coal-getting. This is generally stated to be the depth of the seams. The Royal Commissioners of 1870 based their tables of the quantity of available coal in the visible and concealed coal-fields upon the assumption that 4000 feet is the limit of possible working. This limit is the same that was taken by Mr. Hull ten years earlier. Mr. Hull, in the last edition of "The Coal Fields of Great Britain," p. 326, referring to Professor Ramsay's estimate, says, "These estimates are drawn up for depths down to 4000 feet below the surface, and even beyond this limit; but with this latter quantity it is scarcely necessary that we should concern ourselves." I shall presently show reasons for believing that the time may ultimately arrive when we *shall* concern ourselves with this deep coal, and actually get it; while, on the other hand, that remote epoch will be preceded by another period of practical approximate exhaustion of British coal supply, which is likely to arrive long before we reach a working depth of 4000 feet.

The Royal Commissioners estimate that within the limits of 4000 feet we have hundreds of square miles of attainable coal capable of yielding, after deducting 40 per cent for loss in getting, etc., 146,480 millions of tons; or, if we take this with Mr. Hull's deduction of one-twentieth for seams under two feet in thickness, there remains 139,000 millions of tons, which, at present rate of consumption, would last about 1200 years. But the rate of consumption is annually increasing, not merely on account of increasing population, but also from the fact that mechanical inventions are perpetually superseding hand labor, and the source of power in such cases is usually derived from coal. This consideration induced Professor Jevons, in 1865, to estimate that between 1861 and 1871 the consumption would increase from 83,500,000 tons to 118,000,000 tons. Mr. Hunt's official return for 1871 shows that this estimate was a close approximation to the truth, the actual total for 1871 having been 117,352,028 tons. At this rate of an arithmetical increase of three and a half tons per annum, 139,000 millions of tons would last but 250 years. Mr. Hull, taking the actual increase at three millions of tons per annum, extends it to 276 years. Hitherto the annual increase has followed a geometrical rather than arithmetical progress, and those who anticipate a continuance of this allow us a much shorter lease of our coal treasures. Mr. Price Williams maintains that the increase will proceed in a diminishing ratio like that of the increase of population; and upon this basis he has calculated that the annual consumption will amount to 274 millions of tons a hundred years hence, and the whole available stock of coal will last about 360 years.

The latest returns show, for 1872, an output of 123,546,758 tons, which, compared with 1871, gives a rate of increase of more than double the estimate of Mr. Hull, and indicate that prices have not yet risen sufficiently to check the geometrical rate of increase.* Mr Hull very justly points out the omission in those estimates which do not "take into account the diminishing ratio at which coal must be consumed when it becomes scarcer and more expensive;" but, on the other hand, he omits the opposite influence of increasing prices on production, which has been strikingly illustrated by the extraordinary number of new coal-mining enterprises that have been launched during the last six months. If we continue as we are now proceeding, a practical and permanent coal famine will be upon us within the lifetime of many of the present generation. By such a famine, I do not mean an actual exhaustion of our coal seams (which will never be effected), but such a scarcity and rise of prices as shall annihilate the most voracious of our coal-consuming industries, those which depend upon abundance of cheap coal, such as the manufacture of pig-iron, etc.*

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*From 1870 to 1880 the amount has risen from 110,431,192 to 146,818,622 tons per annum, an average increase of 3,638,743 tons per annum.

The action of increasing prices has been but lightly considered hitherto, though its importance is paramount in determining the limits of our coal supply; I even venture so far as to affirm that it is not the depth of the coal seams, not the increasing temperature nor pressure as we proceed downwards, nor even thinness of seam, that will practically determine the limits of British coal-getting, but simply the price per ton at the pit's mouth.

In proof of this, I may appeal to actual practice. Mr. Hull and others have estimated the working limit of thinness at two feet, and agree in regarding thinner seams than this as unworkable. This is unquestionably correct so long as the getting is effected in the usual manner. A collier cannot lie down and hew a much thinner seam than this, if he works as colliers work at present. But the lead and copper miners succeed in working far thinner lodes, even down to the thickness of a few inches, and the gold-digger crushes the hardest component of the earth's crust to obtain barely visible grains of the precious metal. This extension of effort is entirely determined by market value. At a sufficiently high price the two-feet limit of coal-getting would vanish, and the collier would work after the manner of the lead-miner.

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*At the present time (1882) we are receiving the excessive supplies consequent upon the opening of new pits that, under the stimulus of high prices, were in the course of sinking when the above was written. Hence the present low prices. Presently the annual increase of consumption will overtake this increased supply, and another "coal famine" like that then existing will follow. This is not far distant.

We may safely apply the same reasoning to the limits of depth. The 4000 feet limit of the Royal Commissioners is *at present* unattainable, simply because the immediately prospective price of coal would not cover the cost of such deep sinking and working; but as prices go up, pits will go down, deeper and deeper still.

The obstacles which are assumed to determine the 4000 feet limit are increasing density due to greater pressure, and the elevation of temperature which proceeds as we go downwards. The first of these difficulties has, I suspect, been very much overstated, if not altogether misunderstood; though it is but fair to add that Mr. Hull, who most prominently dwells upon it, does so with all just and philosophic caution. He says that "it is impossible to speak with certainty of the effect of the accumulative weight of 3000 or 4000 feet of strata on mining operations. In all probability one effect would be to increase the density of the coal itself, and of its accompanying strata, so as to increase the difficulty of excavating," and he concludes by stating that "in the face of these two obstacles—temperature and pressure, ever increasing with the depth—I have considered it utopian to include in calculations having reference to coal supply any quantity, however considerable, which lies at a greater depth than 4000 feet. Beyond that depth I do not believe that it will be found practicable to penetrate. Nature rises up, and presents insurmountable barriers."*

On one point I differ entirely from Mr. Hull, viz., the conclusion that the increased "density of the coal itself and of its accompanying strata" will offer any serious obstacle. On the contrary, there is good reason to believe that such density is one of the essential conditions for working deep coal. Even at present depths of working, density and hardness of the accompanying strata is one of the most important aids to easy and cheap coal-getting. With a dense roof and floor the collier works vigorously and fearlessly, and he escapes the serious cost of timbering.

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* The Coal Fields of Great Britain," pp. 447, 448.

Those who have never been underground, and only read of colliery disasters, commonly regard the fire-damp and choke-damp as the collier's most deadly enemies, but the collier himself has quite as much dread of a rotten roof as of either of these: he knows by sad experience how much bruising, and maiming, and crushing of human limbs are due to the friability of the rock above his head. Mr. Hull quotes the case of the Dunkinfield colliery, where, at a depth of about 2500 feet, the pressure is "so resistless as to crush in circular arches of brick four feet thick," and to snap a cast-iron pillar in twain; but he does not give any account of the density of the accompanying strata at the place of these occurrences. I suspect that it was simply *a want of density* that allowed the superincumbent pressure to do such mischief. The circular arches of brick four feet thick were but poor substitutes for a roof of solid rock of 40 or 400 feet in thickness; an arch cut in such a rock would be all key-stone: and I may safely venture to affirm that if, in the deep sinkings of the future, we do encounter the increased density which Mr. Hull anticipates, this will be altogether advantageous. I fear, however, that it will not be so, that the chief difficulty of deep coal-mining will arise from occasional "running in" due to deficient density, and that this difficulty will occur in about the same proportion of cases as at present, but will operate more seriously at the greater depths.

A very interesting subject for investigation is hereby suggested. Do rocks of given composition and formation increase in density as they dip downwards; and if so, does this increase of density follow any law by which we may determine whether their power of resisting superincumbent pressure increases in any approach to the ratio of the increasing pressure to which they are naturally subjected? If the increasing density and power of resistance reaches or exceeds this ratio, deep mining has nothing to fear from pressure. If they fall short of it, the difficulties arising from pressure may be serious. Friability, viscosity, and power of resisting a crushing strain must be considered in reference to this question.

Mr. Hull has collected a considerable amount of data bearing upon the rate of increase of temperature with depth. His conclusions give a greater rate of increase than is generally stated by geologists; but for the present argument I will accept, without prejudice, as the lawyers say, his basis of a range of 1° F. for 60 feet. According to this, the *rocks* will reach 99.6°, a little above blood-heat, at 3000 feet, and 116.3° at the supposed limit of 4000 feet. It is assumed by Mr. Hull, by the Commissioners, and most other authorities, that this rock temperature of 116° will limit the possibilities of coal-mining. At the average prices of the last three years, or the prospective prices of the next three years, this temperature may be, like difficulties of the thin seams, an insurmountable barrier; but I contend that at higher prices we may work coal at this, and even far higher, rock temperatures; that it matters not how high the thermometer rises as we descend, we shall still go lower and still get coal so long as prices rise with the mercury. Given this condition, and I have no doubt that coal may be worked where the rock temperature shall reach or even exceed 212°. I do not say that we shall actually work coal at such depths; but if we do not, the reason will be, not that the thermometer is too high, but that prices are too low; in other words, value, not temperature, will determine the working limits.

Mr. Leifchild, in the last number of the "Edinburgh Review," in discussing this question, tells us that "the normal heat of our blood is 98°, and fever heat commences at 100°, and the extreme limit of fever heat may be taken at 112°. Dr. Thudichum, a physician who has specially investigated this subject, has concluded from experiments on his own body at high temperatures, that at a heat of 140° no work whatever could be carried on, and that at a temperature of from 130° to 140° only a very small amount of labor, and that at short periods, was practicable; and further, that human labor daily, and at ordinary periods, is limited by 100° of temperature, as a fixed point, and then the air must be dry, for in moist air he did not think men could endure ordinary labor at a temperature exceeding 90°."

It may be presumptuous on my part to dispute the conclusions of a physician on such a subject, but I do so nevertheless, as the data required are simple practical facts such as are better obtained by furnace-working than by sick-room experience.

During the hottest days of the summer of 1868 I was engaged in making some experiments in the re-heating furnaces at Sir John Brown & Co.'s works, Sheffield, and carried a thermometer about with me which I suspended in various places where the men were working. At the place where I was chiefly engaged (a corner between two sets of furnaces), the thermometer, suspended in a position where it was not affected by direct radiations from the open furnaces, stood at 120° while the furnace doors were shut. The *radiant* heat to which the men themselves were exposed while making their greatest efforts in placing and removing the piles was far higher than this, but I cannot state it, not having placed the thermometer in the position of the men. In one of the Bessemer pits the thermometer reached 140°, and men worked there at a kind of labor demanding great muscular effort. It is true that during this same week the puddlers were compelled to leave their work; but the tremendous amount of concentrated exertion demanded of the puddler in front of a furnace, which, during the time of removing the balls, radiates a degree of heat quite sufficient to roast a sirloin of beef if placed in the position of the puddler's hands, is beyond comparison with that which would be demanded of a collier working even at a depth giving a theoretical rock temperature of 212°, and aided by the coal-cutting and other machinery that sufficiently high prices would readily command. In some of the operations of glass-making, the ordinary summer working temperature is considerably above 100°, and the radiant heat to which the workmen are subjected far exceeds 212°. This is the case during a "pot setting," and in the ordinary work of flashing crown glass.

As regards the mere endurance of a high temperature, the well-known experiments of Blagden, Sir Joseph Banks, and others have shown that the human body can endure for short periods a temperature of 260° F., and upwards. My own experience of furnace-work, and of Turkish baths, quite satisfies me that I could do a fair day's work of six or eight hours in a temperature of 130° F., provided I were free from the encumbrances of clothing, and had access to abundance of tepid water. This in a still atmosphere; but with a moving current of dry air capable of promoting vigorous evaporation from the skin, I suspect that the temperature might be ten or fifteen degrees higher. I *enjoy* ordinary walking exercise in a well-ventilated Turkish bath at 150°, and can endure it at 180°.

In order to obtain further information on this point, I have written to Mr. Tyndall, the proprietor of the Turkish baths at Newington Butts. He is an architect, who has had considerable experience in the employment of workmen and in the construction of Turkish baths and other hot-air chambers. He says: "Shampooers work in my establishment from four to five hours at a time *in a moist atmosphere* at a temperature ranging from 105° to 110°. I have myself worked twenty hours out of twenty-four in one day in a temperature over 110°. Once for one half-hour I shampooed in 185°. At the enamel works in Pimlico, belonging to Mr. Mackenzie, men work daily in a heat of over 300°. The moment a man working in a 110° heat begins to drink alcohol, his tongue gets parched, and he is obliged to continue drinking while at work, and the brain gets so excited that he cannot do half the amount. I painted my skylights, taking me about four hours, at a temperature of about 145°; also the hottest room skylights, which took me one hour, coming out at intervals for "a cooler," at a temperature of 180°. I may add in conclusion, that a man can work well in a moist temperature of 110° if he perspires freely."

The following, by a writer whose testimony may be safely accepted, is extracted from an account of ordinary passenger ships of the Red Sea, in the "Illustrated News," of November 9, 1872: "The temperature in the stoke-hole was 145°. The floor of this warm region is close to the ship's keel, so it is very far below. There are twelve boilers, six on each side, each with a blazing furnace, which has to be opened at regular intervals to put in new coals, or to be poked up with long iron rods. This is the duty of the poor wretches who are doomed to this work. It is hard to believe that human beings could be got to labor under such conditions, yet such persons are to be found. The work of stoking or feeding the fires is usually done by Arabs, while the work of bringing the coal from the bunkers is done by sidi-wallahs or negroes. At times some of the more intelligent of these *are promoted to the stoking*. The negroes who do this kind of work come from Zanzibar. They are generally short men, with strong limbs, round bullet heads, and the very best of good nature in their dispositions. Some of them will work half an hour in such a place as the stoke-hole without a drop of perspiration on their dark skins. Others, particularly the Arabs, when it is so hot as it often is in the Red Sea, have to be carried up in a fainting condition, and are restored to animation by dashing buckets of water over them as they lie on deck."

It must be remembered that the theoretical temperature of 116° at 4000 feet, the 133° at 5000 feet, or the 150° at 6000 feet, are the temperatures of *the undisturbed rock;* that this rock is a bad conductor of heat, whose surface may be considerably cooled by radiation and convection; and therefore we are by no means to regard the rock temperature as that of the air of the roads and workings of the deep coal-pits of the future.* It is true that the Royal Commissioners have collected many facts showing that the actual difference between the face of the rocks of certain pits and the air passing through them is but small; but these data are not directly applicable to the question under consideration for the three following reasons:

First. The comparisons are made between the temperature of the air and the actual temperature of the opened

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*In a paper on the Comstock mines, read at the Pittsburg meeting of the American Institute of Mining Engineers in 1879, by Mr. John A. Church, the hot mine waters are described as reaching 158° Fahr. (so hot that men have been scalded to death by falling into them). The highest recorded *air temperature* there is 128°. These are silver mines, and vigorously worked in spite of this temperature and great humidity. A much higher temperature is endurable in *dry air*.

and already cooled strata, while the question to be solved is the difference between the theoretical temperature of the unopened earth depths and that of the air in roads and workings to be opened through them.

Second. The cooling effect of ventilation must (as the Commissioners themselves state) increase in a ratio which "somewhat exceeds the ratio of the difference between the temperature of the air and that of the surrounding surface with which it is in contact." Thus, the lower we proceed the more and more effectively cooling must a given amount of ventilation become.

The third, and by far the most important, reason is, that in the deep mining of the future, special means will be devised and applied to the purpose of lowering the temperature of the workings; that as the descending efforts of the collier increase with the ascending value of the coal, a new problem will be offered for solution, and the method of working coal will be altered accordingly. In the cases quoted by the Commissioners, the few degrees of cooling were effected by a sytem of ventilation that was devised to meet the requirements of respiration, and not for the purpose of cooling the mine.

It would be very presumptuous for anyone in 1873 to say how this special cooling will actually be effected, but I will nevertheless venture to indicate one or two principles which may be applied to the solution of the problem. First of all, it must be noted that very deep mines are usually dry; and there is good reason to believe that, before reaching the Commissioners' limit of 4000 feet, dry mining would be the common, and at and below 4000 feet the universal, case. At present we usually obtain coal from water-bearing strata, and all our arrangements are governed by this very serious contingency. With water removed, the whole system of coal-mining may be revolutionized, and thus the aspect of this problem of cooling the workings would become totally changed.

Those who are acquainted with the present practice of mining are aware that when an estate is taken, and about to be worked for coal, the first question to be decided is the dip of the measures, in order that the sinking may be made "on the deep" of the whole range. The pits are not sunk at that part of the same range where, at first sight, the coal appears the most accessible, but, on the contrary, at the deepest part. It is then carried on to some depth below the coal seam which is to be worked, in order to form a "sumpf" or receptacle from which the water may be wound or pumped. The necessity for this in water-bearing strata is obvious enough. If the collier began at the shallowest portion of his range, and attempted to proceed downwards, he would be "drowned out" unless he worked as a coal-diver rather than a coal-miner. By sinking in the deep he works upwards, away from the water, which all drains down to the sumpf, from which it is pumped.

The modern practice is to sink "a pair of pits," *both on the deep*, and within a short distance of each other. The object of the second is ventilation. By contrivances, which I need not here detail, the air is made to descend one of the pits, "the downcast shaft," then to traverse the roads and workings wherein ventilation is required, and return by a reverse route to the "upcast shaft," by which it ascends to the surface.

Thus it will be seen that, whenever the temperature of the roads and workings exceeds that of the outer atmosphere; the air currents have to be forced to travel through the mine in a direction contrary to their natural course. The cooler air of the downcast shaft has to climb the inclined roads, and then after attaining its maximum temperature in the fresh workings must *descend* the roads till it reaches the upcast shaft. The cool air must rise and the warmer air descend.

What, then, would be the course of the mining engineer when all the existing difficulties presented by water-bearing strata should be removed, and their place taken by a new and totally different obstacle, viz., high temperature? Obviously to reverse the present mode of working—to sink on the upper part of the range and drive downwards. In such a system of working the ventilation of the pit will be most powerfully aided or altogether effected by natural atmospheric currents. An upcast once determined by artificial means, it will thereafter proceed spontaneously, as the cold air of the downcast shaft will travel by a descending road to the workings, and then after becoming heated will simply obey the superior pressure of the heavy column behind, and proceed by an upward road to the upcast shaft. As the impelling force of the air current will be the difference between the weight of the cool column of air in the downcast shaft and roads and the warm column in the upcast, the available force of natural ventilation and cooling will increase just as demanded, *i.e.*, it will increase with the depth of the workings and the heat of the rocks. A mining engineer who knows what is actually done with present arrangements, will see at once that with the above-stated advantages a gale of wind or even a hurricane might be directed through any particular roads or long-wall workings that were once opened. Let us suppose the depth to be 5000 feet, the rock temperature at starting 133°, and that of the outer air 60°, we should have a torrent of air, 73° cooler than the rocks, rushing furiously downwards, then past the face of the heated strata, and absorbing its heat to such an exent that the upcast shaft would pour forth a perpetual blast of hot air like a gigantic furnace chimney.

But this is not all; the heat and dryness of these deep workings of the future place at our disposal another and still more efficient cooling agency than even that of a hurricane of dry-air ventilation. In the first part of the sinking of the deep shafts the usual water-bearing strata would be encountered, and the ordinary means of "tubbing" or "coffering" would probably be adopted for temporary convenience during sinking. Doorways, however, would be left in the tubbing at suitable places for tapping at pleasure the wettest and most porous of the strata. Streams of cold water could thus be poured down the sides of the shaft, which, on reaching the bottom, would flow by a downhill road into the workings. The stream of air rushing by the same route and becoming heated in its course would powerfully assist the evaporation of the water. The deeper and hotter the pit, the more powerful would be these cooling agencies.

As the specific heat of water is about five times that of the coal-measure rocks, or the coal itself, every degree of heat communicated to each pound of water would abstract one degree from five pounds of rocks. But in the conversion of water at 60° into vapor at say 100°, the amount of heat absorbed is equivalent to that required to raise the same weight of water about 1000°, and thus the effective cooling power on the rock would be equivalent to 5000°.

The workings once opened (I assume as a matter of course that by this time pillar-and-stall working will be enterely abandoned for long-wall or something better), there would be no difficulty in thus pouring streams of water and torrents of air through the workings during the night, or at any suitable time preparatory to the operations of the miner, who long before the era of such deep workings will be merely the director of coal-cutting and loading machinery.

Given a sufficiently high price for coal at the pit's mouth to pay wages and supply the necessary fixed capital, I see no insuperable difficulty, *so far as mere temperature is concerned,* in working coal at double the depth of the Royal Commissioners' limit of possibility. At such a depth of 8000 feet the theoretical rock-temperature is 183°.

By the means above indicated, I have no doubt that this could be reduced to an *air* temperature below 110°—that at which Mr. Tyndall's shampooers ordinarily work. Of course the newly-exposed face of the coal would have its initial temperature of 183°; but this is a trivial heat compared to the red-hot radiant surfaces to which puddlers, shinglers, glassmakers, etc., are commonly exposed. Divested of the incumbrance of clothing, with the whole surface of the skin continuously fanned by a powerful stream of air—which, during working hours need be but partly saturated with vapor—a sturdy midland or north-countryman would work merrily enough at short hours and high wages, even though the newly-exposed face of coal reached 212°; for we must remember that this new coal-face would only correspond to the incomparably hotter furnace-doors and fires of the steamship stoke-holes.

The high temperature at 8000 or even 10,000 feet would present a really serious difficulty during the first opening of communications between the two pits. A spurt of brave effort would here be necessary, and if anybody doubts whether Englishmen could be found to make the effort, let him witness a "pot-setting" at a glass-house. Negro labor might be obtained if required, but my experience among English workmen leads me to believe that they will never allow negroes or any others to beat them at home in any kind of work where the wages paid are proportionate to the effort demanded.

If I am right in the above estimates of working possibilities, our coal resources may be increased by about forty thousand millions of tons beyond the estimate of the Commissioners. To obtain such an additional quantity will certainly be worth an effort, and unless we suffer a far worse calamity than the loss of all our minerals, viz., a deterioration of British energy, the effort will assuredly be made.

I have said repeatedly that it is not physical difficulties but market value that will determine the limits of our coal-mining. This, like all other values, is of course determined by the relation between demand and supply. Fuel being one of the absolute necessaries of life, the demand for it must continue so long as the conditions of human existence remain as at present, and the outer limits of the possible value of coal will be determined by that of the next cheapest kind of fuel which is capable of superseding it.

We begin by working the best and most accessible seams, and while those remain in abundance the average value of coal will be determined by the cost of producing it under these easy conditions. Directly these most accessible seams cease to supply the whole demand, the market value rises until it becomes sufficient to cover the cost of working the less accessible; and the average value will be regulated not by the cost of working what remains of the first or easy mines, but by that of working the most difficult that must be worked in order to meet the demand. This is a simple case falling under the well-established economic law, that the natural or cost value of any commodity is determined by the cost value of the most costly portion of it. Thus, the only condition under which we can proceed to sink deeper and deeper, is a demand of sufficient energy to keep pace with the continually increasing cost of production. This condition can only be fulfilled when there is no competing source of cheaper production which is adequate to supply the demand.

The question then resolves inself into this: Is any source of supply likely to intervene that will prevent the value of coal from rising sufficiently to cover the cost of working the coal seams of 4000 feet and greater depth? Without entering upon the question of peat and wood fuel, both of which will for some uses undoubtedly come into competition with British coal as it rises in value, I believe that there are sound reasons for concluding that our London fireplaces, and those of other towns situated on the sea-coast and the banks of navigable rivers, will be supplied with transatlantic coal long before we reach the Commissioner's limit of 4000 feet. The higest prices of last winter, if steadily maintained, would be sufficient to bring about this important change. Temporary upward jerks of the price of coal have very little immediate effect upon supply, as the surveying, conveyance, boring, sinking, and fully opening of a new coal estate is a work of some years.

The Royal Commissioners estimate that the North-American coal-fields contain an untouched coal area equal to seventy times the whole of ours. Further investigation is likely to increase rather than diminish this estimate. An important portion of this vast source of supply is well situated for shipment, and may be easily worked at little cost. Hitherto, the American coal-fields have been greatly neglected, partly on account of the temptations to agricultural occupation which are afforded by the vast area of the American continent, and partly by the barbarous barriers of American politics. Large amounts of capital which, under the social operation of the laws of natural selection, would have been devoted to the unfolding of the vast mineral resources of the United States, are still wastefully invested in the maintenance of protectively nursed and sickly imitation of English manufactures. When the political civilization of the United States become sufficiently advanced to establish a national free-trade policy, this perverted capital will flow into its natural channels, and the citizens of the States will be supplied with the more highly elaborated industrial products at a cheaper rate than at present, by obtaining them in exchange for their superabundant raw material from those European countries where population is overflowing the raw material supplies.

When this time arrives, and it may come with the characteristic suddenness of American changes, the question of American *versus* English coal in the English markets will reduce itself to one of horizontal *versus* vertical difficulties. If at some future period the average depth of the Newcastle coal-pits becomes 3000 feet greater than those of the pits near the coast of the Atlantic or American lakes, and if the horizontal difficulties of 3000 miles of distance are less than the vertical difficulties of 3000 feet of depth, then coals will be carried from America to Newcastle. They will reach London and the towns on the South Coast before this, that is, when the vertical difficulties at Newcastle plus those of horizontal traction from Newcastle to the south, exceed those of eastward traction across the Atlantic.

As the cost of carriage increases in a far smaller ratio than the open ocean distance, there is good reason for concluding that the day when London houses will be warmed by American coal is not very far distant. We, in England, who have outgrown the pernicious folly of "protecting native industry,' will heartily welcome so desirable a consummation. It will render unnecessary any further inquiry into the existence of London "coal rings" or combinations for restricted output among colliers or their employers. If any morbid impediments to the free action of the coal trade do exist, the stimulating and purgative influence of foreign competition will rapidly restore the trade to a healthy condition.

The effect of such introduction of American coal will not be to perpetually lock up our deep coal nor even to stop our gradual progress towards it. We shall merely proceed downwards at a much slower rate, for in America, as with ourselves, the easily accessible coal will be first worked, and as that becomes exhausted, the deeper, more remote, thinner, and inferior will only remain to be worked at continually increasing cost. When both our own and foreign coal cost more than peat, or wood, or other fuel, then and therefore will coal become quite inaccessible to us, and this will probably be the case long before we are stopped by the physical obstacles of depth, density, or high temperature.

As this rise of value must of necessity be gradual, and as the superseding of British by foreign coal, as well as the final disuse of coal, will gradually converge from the circumference towards the centres of supply, from places distant from coal-pits to those close around them, we shall have ample warning and opportunity for preparing for the social changes that the loss of the raw material will enforce.

The above-quoted writer, in the "Edinburgh Review," expresses in strong and unqualified terms an idea that is very prevalent in England and abroad: he says that, "The course of manufacturing supremacy of wealth and of power is directed by coal. That wonderful mineral, of the possession of which Englishmen have thought so little but wasted so much, is the modern realization of the philosopher's stone. This chemical result of primeval vegetation has been the means by its abundance of raising this country to an unprecedented height of prosperity, and its deficiency might have the effect of lowering it to slow decline."

* * "It raises up one people and casts down another: it makes railways on land and paths on the sea. It founds cities, it rules nations, it changes the course of empires."

The fallacy of these customary attributions of social potency to mere mineral matter is amply shown by facts that are previously stated by the reviewer himself. He tells us that "the coal-fields of China extend over an area of 400,000 square miles; and a good geologist, Baron Von Richthofen, has reported that he himself has found a coal-field in the province of Hunan covering an area of 21,700 square miles, which is nearly double our British coal area of 12,000 square miles. In the province of Shansi, the Baron discovered nearly 30,000 square miles of coal with unrivaled facilities for mining. But all these vast coal-fields, capable of supplying the whole world for some thousands of years to come, are lying unworked."

If "the course of manufacturing supremacy of wealth and of power" were directed by coal, then China, which possesses 33·3 times more of this directive force than Great Britain, and had so early a start in life, should be the supreme summit of the industrial world. If this solid hydrocarbon "raises up one people and casts down another," the Chinaman should be raised thirty-three times and three tenths higher than the Englishman; if it "makes railways on land and paths on the sea," the Chinese railways should be 33·3 times longer than ours, and the tonnage of their mercantile marine 33·3 times greater.

Every addition to our knowledge of the mineral resources of other parts of the world carries us nearer and nearer to the conclusion that the old idea of the superlative abundance of the natural mineral resources of England is a delusion. We are gradually discovering that, with the one exception of tin-stone, we have but little if any more than an average supply of useful ores and mineral fuel. It is a curious fact, and one upon which we may profitably ponder, that the poorest and the worst iron ores that have ever been commercially reduced, are those of South Staffordshire and the Cleveland district, and these are the two greatest iron-making centres of the world. There are no ores of copper, zinc, tin, nickel, or silver in the neighborhood of Birmingham, nor any golden sands upon the banks of the Rea, yet this town is the hardware metropolis of the world, the fatherland of gilding and plating, and is rapidly becoming supreme in the highest art of gold and silver work.

These, and a multitude of other analogous facts, abundantly refute the idea that the native minerals, the natural fertility, the navigable rivers, or the convenient seaports, determine the industrial and commercial supremacy of nations. The moral forces exerted by the individual human molecules are the true components which determine the resulting force and direction of national progress. It is the industry and skill of our workmen, the self-denial, the enterprise, and organizing ability of our capitalists, that has brought our coal so precociously to the surface and redirected for human advantage the buried energies of ancient sunbeams, while the fossil fuel of other lands has remained inert.

The foreigner who would see a sample of the source of British prosperity must not seek for it in a geological museum or among our subterranean rocks; let him rather stand on the Surrey side of London Bridge from 8 to 10 A.M. and contemplate the march of one of the battalions of our metropolitan industrial army, as it pours forth in an unceasing stream from the railway stations towards the City. An analysis of the moral forces which produce the earnest faces and rapid steps of these rank and file and officers of commerce will reveal the true elements of British greatness, rather than any laboratory dissection of our coal or ironstone.

Fuel and steam-power have been urgently required by all mankind. Englishmen supplied these wants. Their urgency was primary and they were first supplied, even though the bowels of the earth had to be penetrated in order to obtain them. In the present exceptional and precocious degree of exhaustion of our coal treasures, we have the *effect* not the *cause* of British industrial success.

If in a ruder age our greater industrial energy enabled us to take the lead in supplying the ruder demands of our fellow-creatures, why should not a higher culture of those same abundant energies qualify us to maintain our position and enable us to minister to the more refined and elaborate wants of a higher civilization? There are other necessary occupations quite as desirable as coal-digging, furnace-feeding, and cotton-spinning.

The approaching exhaustion of our coal supplies should therefore serve us as a warning for preparation. Britain will be forced to retire from the coal trade, and should accordingly prepare her sons for higher branches of business,—for those in which scientific knowledge and artistic training will replace mere muscular strength and mechanical skill. We have attained our present material prosperity mainly by our excellence in the use of steam-power; let us now struggle for supremacy in the practical application of brain-power.

We have time and opportunity for this. The exhaustion of our coal supplies will go on at a continually retarding pace—we shall always be approaching the end, but shall never absolutely reach it, as every step of approximation will diminish the rate of approach; like the everlasting process of reaching a given point by continually halving our distance from it.

First of all we shall cease to export coal; then we shall throw up the most voracious of our coal-consuming industries, such as the reduction of iron-ore in the blast-furnace; then copper-smelting and the manufacture of malleable iron and steel from the pig, and so on progressively. If we keep in view the natural course and order of such progress, and intelligently prepare for it, the loss of our coal need not in the smallest degree retard the progress of our national prosperity.

If, however, we act upon the belief that the advancement of a nation depends upon the mere accident of physical advantages, if we fold our arms and wait for Providence to supply us with a physical substitute for coal, we shall become Chinamen, minus the unworked coal of China.

If our educational efforts are conducted after the Chinese model; if we stultify the vigor and freshness of young brains by the weary, dull, and useless cramming of words and phrases; if we poison and pervert the growing intellect of British youth by feeding it upon the decayed carcases of dead languages, and on effete and musty literature, our progress will be proportionately Chinaward; but if we shake off that monkish inheritance which leads so many of us blindly to believe that the business of education is to produce scholars rather than men, and direct our educational efforts towards the requirements of the future rather than by the traditions of the past, we need have no fear that Great Britain will decline with the exhaustion of her coal-fields.

The teaching and training in schools and colleges must be directly and designedly preparatory to those of the workshop, the warehouse, and the office; for if our progress is to be worthy of our beginning, the moral and intellectual dignity of industry must be formally acknowledged and systematicallly sustained and advanced. Hitherto, we have been the first and the foremost in utilizing the fossil forces which the miner has unearthed; hereafter we must in like manner avail ourselves of the living forces the philosopher has revealed. Science must become as familiar among all classes of Englishmen as their household fuel. The youth of England must be trained to observe, generalize, and *investigate* the phenomena and forces of the world outside themselves; and also those moral forces within themselves, upon the right or wrong government of which the success or failure, the happiness or misery of their lives will depend.

With such teaching and training the future generations of England will make the best and most economical use of their coal while it lasts, and will still advance in material and moral prosperity in spite of its progressive exhaustion.

"THE ENGLISHMAN'S FIRESIDE."

During the investment of Paris, the *Comptes Rendus* of the Acadamy of Sciences were mainly filled with papers on the construction and guidance of balloons; with the results of ingenious researches on methods of making milk and butter without the aid of cows; on the extraction of nutritious food from old boots, saddles, and other organic refuse; and other devices for rendering the general famine more endurable. In like manner, our present coal famine is directing an important amount of scientific, as well as commercial, attention to the subject of economizing coal and finding substitutes for it.

A few thoughtful men have shocked their fellow-sufferers very outrageously by wishing that coal may reach 3*l.* per ton, and remain at that price for a year or two. I confess that, in spite of my own empty coal-cellar and small income, I am one of those hard-hearted cool calculators, being confident that, even from the narrow point of view of my own outlay in fuel, the additional amount I should thus pay in the meantime would be a good investment, affording by an ample return in the saving due to consequent future cheapness.

Regarded from a national point of view, I am convinced that 3*l.* a ton in London, and corresponding prices in other districts, if thus maintained, would be an immense national blessing. I say this, being convinced that nothing short of pecuniary pains and penalties of ruinous severity will stir the blind prejudices of Englishmen, and force them to desist from their present stupid and sinful waste of the greatest mineral treasure of the island.

One of the grossest of our national manifestations of Conservative stupidity is our senseless idolatrous worship of that domestic fetish, "the Englishman's fireside." We sacrifice health, we sacrifice comfort, we begrime our towns and all they contain with sooty foulness, we expend an amount far exceeding the interest of the national debt, and discount our future prospects of national prosperity, in order that we may do what? Enjoy the favorite recreation of idiots. It is a well-known physiological fact that an absolute idiot, with a cranium measuring sixteen inches in circumference, will sit and stare at a blazing fire for hours and hours continuously, all the day long, except when feeding, and that this propensity varies with the degree of mental vacuity.

Few sights are more melancholy than the contemplation of a party of English fire-worshipers seated in a semicircle round the family fetish on a keen frosty day. They huddle together, roast their knees, and grill their faces, in order to escape the chilling blast that is brought in from all the chinks of leaky doors and windows by the very agent they employ, at so much cost, for the purpose of keeping the cold away. The bigger the fire the greater the draught, the hotter their faces the colder their backs, the greater the consumption of coal the more abundant the crop of chilblains, rheumatism, catarrh, and other well-deserved miseries.

The most ridiculous element of such an exhibition is the complacent self-delusion of the victims. They believe that their idol bestows upon them an amount of comfort unknown to other people, that it affords the most perfect and salubrious ventilation, and, above all, that it is a "cheerful" institution. The "cheerfulness" is, perhaps, the broadest part of the whole caricature, especially when we consider that, according to this theory of the cheerfulness of fire-gazing, the 16-inch idiot must be the most cheerful of all human beings.

The notion that our common fireplaces and chimneys afford an efficient means of ventilation, is almost too absurd for serious discussion. Everybody who has thought at all on the subject is aware that in cold weather the exhalations of the skin and lungs, the products of gas-burning, etc., are so much heated when given off that they rise to the upper part of the room (especially if any cold outer air is admitted), and should be removed from there before they cool again and descend. Now, our fireplace openings are just where they ought *not* to be for ventilation; they are at the lower part of the room, and thus their action consists in creating a current of cold air or "draught" from doors and windows, which cold current at once descends, and then runs along the floor, chilling our toes and provoking chilblains.

This cold fresh air having done its worst in the way of making us uncomfortable, passes directly up the chimney without doing us any service for purposes of respiration. Our mouths are usually above the level of the chimney opening, and thus we only breathe the vitiated atmosphere which it fails to remove.

Not only does the fire-opening fail to purify the air we breathe, it actually prevents the leakage of the lower part of the windows and doors from assisting in the removal of the upper stratum of vitiated air, for the strong up-draught of the chimney causes these openings to be fully occupied by an inflowing current of cold air, which at once descends, and then proceeds, as before stated, to the chimney. If the leakage is insufficient to supply the necessary amount of chilblain-making and bronchitis-producing draught, it has to enter by way of the chimney-pot in the form of occasional spasms of down-draught, accompanied by gusts of choking and blackening smoke. It is a fact not generally known, that smoky chimneys are especial English institutions, one of the peculiar manifestations of our very superior domestic comfortableness.

It is true that, in some of our rooms, an Arnott's ventilator opens into the upper part of the chimney, but this was intended by Dr. Arnott as an adjunct to his modification of the German stove, and such ventilator can only act efficiently where a stove is used. The pressure required to fairly open it can only be regularly obtained when the chimney is closed below, or its lower opening is limited to that of a stovepipe.

The mention of a German stove has upon an English fire-worshiper a similar effect to the sight of water upon a mad dog. Again and again, when I have spoken of the necessity of reforming our fireplaces, the first reply elicited has been, "What, would you have us use German stoves?" In every case where I have inquired of the exclaimer, "What sort of a thing is a German stove?" the answer has proved that the exclamation was but a manifestation of blind prejudice based upon total ignorance. These people who are so much shocked at the notion of introducing "German stoves" have no idea of the construction of the stoves which deservedly bear this title. Their notion of a German stove is one of those wretched iron boxes of purely English invention known to ironmongers as "shop stoves." These things get red hot, their red-hot surface frizzles the dust particles that float in the atmosphere and perfume the apartment accordingly. This, however disagreeable, is not very mischievous, perhaps the reverse, as many of these dust particles, which are revealed by a sunbeam, are composed of organic matter which, as Dr. Tyndall argues, may be carriers of infection. If we must inhale such things, it is better that we should breathe them cooked than take them raw.

The true cause of the headaches and other mischief which such stoves unquestionably induce is very little understood in this country. It has been falsely attributed to overdrying of the atmosphere, and accordingly evaporating pans and other contrivances have been attached to such stoves, but with little or no advantage. Other explanations are given, but the true one is that iron *when red hot is permeable by carbonic oxide.* This was proved by the researches of Professor Graham, who showed that this gas not only *can* pass through red-hot iron with singular facility, but actually *does* so whenever there is atmospheric air on one side and carbonic oxide on the other.

For the benefit of my non-chemical readers, I may explain that when any of our ordinary fuel is burned there are two products of carbon combustion, one the result of complete combustion, the other of semi-combustion—carbonic acid and carbonic oxide—the former, though suffocating when breathed alone or in large proportion, is not otherwise poisonous, and has no disagreeable odor; it is in fact rather agreeable in small quantities, being the material of champagne bubbles and of those of other effervescing drinks. Carbonic oxide, the product of semi-combustion, is quite different. Breathed only in small quantities, it acts as a direct poison, producing peculiarly oppressive headaches. Besides this, it has a disagreeable odor. It thus resembles many other products of imperfect combustion, such as those which are familiar to everbody who has ever blown out a tallow candle, and left the red wick to its own devices.

On this account alone any kind of iron stove capable of becoming red-hot should be utterly condemned. If Englishmen did their traveling in North Europe in the winter, their self-conceit respecting the comfort of English houses would be cruelly lacerated, and none such would perpetrate the absurdity of applying the name of "German stove" to the iron fire-pots that are sold as stoves by English ironmongers.

As the Germans use so great a variety of stoves, it is scarcely correct to apply the title of German to any kind of stove, unless we limit ourselves to North Germany. There, and in Sweden, Denmark, Norway, and Russia, the construction of stoves becomes a specialty. The Russian stove is perhaps the most instructive to us, as it affords the greatest contrast to our barbarous device of a hole in the wall into which fuel is shoveled, and allowed to expend nine-tenths of its energies in heating the clouds, while only the residual ten per cent does anything towards warming the room. With the thermometer outside below zero, a house in Moscow or St. Petersburg is kept incomparably more warm and comfortable, and is *better* ventilated (though, perhaps, not so *much* ventilated) than a corresponding class of house in England, where the outside temperature is 20 or 30 degrees higher, and this with a consumption of about one-fourth of the fuel which is required for the production of British bronchitis.

This is done by, first of all, sacrificing the idiotic recreation of fire-gazing, then by admitting no air into the chimney but that which is used for the combustion of the fuel; thirdly, by sending as little as possible of the heat up the chimney; fourthly, by storing the heat obtained from the fuel in a suitable reservoir, and then allowing it gradually and steadily to radiate into the apartment from a large but not overheated surface.

The Russian stove by which these conditions are fulfilled is usually an ornamental, often a highly artistic, handsome article of furniture, made of fire-resisting porcelain, glazed and otherwise decorated outside. Internally it is divided by thick fire-clay walls into several upright chambers or flues, usually six. Some dry firewood is lighted in a suitable fireplace, and is supplied with only sufficient air to effect combustion, all of which enters below and passes fairly through the fuel. The products of combustion being thus undiluted with unnecessary cold air, are very highly heated, and in this state pass up compartment or flue No. 1; they are then deflected, and pass down No. 2; then up No. 3, then down No. 4, then up No. 5, then down No. 6. At the end of this long journey they have given up most of their heat to the 24 heat-absorbing surfaces of the fire-clay walls of the six flues.

When the interior of the stove is thus sufficiently heated, the fire-door and the communication with the chimney are closed, and the fire is at once extinguished, having now done its day's work; the interior of the stove has bottled up its calorific force, and holds its ready fore mission into the apartment. This is effected by the natural properties of the walls of the earthenware reservoir. They are bad conductors and good radiators. The heat slowly passes through to the outside of the stove, is radiated into the apartment from a large and moderately-heated surface, which affords a genial and well-diffused temperature throughout.

There is no scorching in one little red-hot hole, or corner, or box, and freezing in the other parts of the room. There are no draughts, as the chimney is quite closed as soon as the heat reservoir is supplied. If one of these heat reservoirs is placed in the hall, where it may form a noble ornament and can easily communicate with an underground flue, it warms every part of the house, and enables the Russian to enjoy a luxurious temperate climate indoors in spite of arctic winter outside.

In a house thus warmed and free from draughts or blasts of cold air, ventilation becomes the simplest of problems. Nothing more is required than to provide an inlet and outlet in suitable places, and of suitable dimensions, when the difference between the specific gravity of the cold air without and warm air within does all the rest. Nothing is easier to arrange than to cause all the entering air to be warmed on its way by the hall stove, and to regulate the supply which each apartment shall receive from this general or main stream by adjusting its own upper outlet. In our English houses, with open chimneys, all such systematic, scientific ventilation is impossible, on account of the dominating, interfering, useless, and comfort-destroying currents produced by these wasteful air-shafts.

I should add that the Russian porcelain reservoirs may be constructed for a heat supply of a few hours or for a whole day, and I need say nothing further in refutation of the common British prejudice which confounds so admirable and truly scientific a contrivance with the iron fire-pot above referred to.

There is another kind of stove, which, for the sake of distinction, I may call Scandinavian, as it is commonly used in Norway, Sweden, and Denmark, besides some parts of North Germany. This is a tall, hollow iron pillar, of rectangular section, varying from three to six feet in width, and rising half-way to the ceiling of the room, and sometimes higher. A fire is lighted at the lower part, and the products of combustion, in their way upwards, meet with horizontal iron plates, which deflect them first to the right, then to the left, and thus compel them to make a long serpentine journey before they reach the chimney. By this means they give off their heat to the large surface of iron plate, and enter the chimney at a comparatively low temperature. The heat is radiated into the apartment from the large metal surface, no part of which approaches a red-heat. A further economy is commonly effected by placing this iron pillar in the wall separating two rooms, so that one of its faces is in each room. Thus two rooms are heated by one fire. One of these may be the kitchen, and the same fire that prepares the food may be used to warm the dining-room. The fire-worshiper is of course deprived of his "cheerful" occupation of staring at the coals, and he also loses his playthings, as neither poker, tongs, nor coal-scuttle are included in the furniture of an apartment thus heated. People differently constituted consider that an escape from the dust, dirt, and clatter of these is a decided advantage.

Of course these stoves of our northern neighbors are costly—may be very costly when highly ornamental. The stove of a Norwegian "bonder," or peasant proprietor, costs nearly half as much as the two-roomed wooden house in which it is erected, but the saving it effects renders it a good investment. It would cost 100*l.* or 200*l.* to fit up an English mansion with suitable porcelain stoves of the Russian pattern, but a saving of 20*l.* a year in fuel would yield a good return as regards mere cost, while the gain in comfort and healthfulness would be so great that, once enjoyed and understood, such outlay would be willingly made by all who could afford it, even if no money saving were effected.

Only last week I was discussing this question in a railway carriage, where one of my fellow-passengers was an intelligent Holsteiner. He confirmed the heresy by which I had shocked the others, in exulting in the high price of coal, and wishing it to continue. He told us that when wood was abundant in his country, fuel was used as barbarously, as wastefully, and as inefficiently as it now is here, but that the diforesting of the land, and the great cost of fuel, forced upon them a radical reform, the result of which is that they now have their houses better warmed, and at a less cost than when fuel was obtainable at one fourth of its present cost.

Such will be the case with us also if we can but maintain the present coal famine during one or two more winters, especially if we should have the further advantage of some very severe weather in the meantime. Hence the cruel wishes above expressed. The coal famine would scarcely be necessary if we had Russian winters, for in such case our houses, instead of being as they are, merely the most uncomfortable in North Europe, would be quite uninhabitable. With our mild winters we require the utmost severity of fuel prices to civilize our warming and ventilating devices.

"BAILY'S BEADS."

TO THE EDITOR OF THE *Times*.

SIR,—The curious breaking up of the thin annular rim of the sun which is uncovered just before and just after totality, or which surrounds the moon during an annular eclipse, has been but occasionally observed, and some scepticism as to the accuracy of Baily's observations has lately arisen. Having attempted an explanation of the "beads," I have looked with much interest for the reports of the eclipse of 1870, for, if I am right, they ought to have been well seen on this occasion. This has been the case. We are informed that both Lord Lindsay and the Rev. S. J. Perry have observed them, and that Lord Lindsay has set aside all doubts respecting their reality by securing a photographic record of their appearance.

My explanation is that they are simply sun-spots seen in profile—spots just caught in the fact of turning the sun's edge. All observers are now agreed as to the soundness of Galileo's original description of the spots—that they are huge cavities, great rifts of the luminous surface of the sun, many thousands of miles in diameter, and probably some thousand miles deep. Let us suppose the case of a spot—say, 2,000 miles deep and 10,000 miles across (Sir W. Herschel has measured spots of 50,000 miles diameter).

When such a spot in the course of the sun's rotation reaches that part which forms the visible edge of the sun, it must, if rendered visible, be seen as a notch; but what will be the depth of such a notch? Only about 1-430th of the sun's diameter. But the apparent depth would be much less as the edge or rim of the spot next to the observer would cut off more or less of its actually visible depth, this amount depending upon the lateral or east and west diameter of the spot and its position at the time of observation.

Thus, the visible depth of such a notch would rarely exceed one thousandth of the sun's apparent diameter, or might be much less. The sun being globular, the edge which is visible to us is but our horizon of his fiery ocean, which we see athwart the intervening surface as it gradually bends away from our view. So small an indent upon this edge would, under ordinary circumstances of observation, be rendered quite invisible by the irradiation of the vast globular surface of the glaring photosphere, upon which it would visually encroach.

If, however, this body of glare could be screened off, and only a line of the sun's edge, less than one thousandth of his diameter, remain visible, the notch would appear as a distinct break in this curved line of light. If a group of spots, or a great irregular spot with several umbræ, were at such a time situated upon the sun's edge, the appearance of a series of such notches or breaks leaving intermediate detachments of the visible ring of the photosphere would be the necessary result, and thus would be presented exactly the appearance described as "Baily's beads."

I have been led to anticipate a display of these beads during the late eclipse by the fact that some days preceding it a fine group or spots—visible to the naked eye through a London fog—were traveling towards the eastern edge of the sun, and should have reached the limb at about the time of the eclipse. The beads were observed by the Rev. S. J. Perry just where I expected them to appear. I have not yet learnt on which side of the sun they were observed and photographed by Lord Lindsay.

Baily's first observation of the beads was made during the annular eclipse of May 15, 1836. That year, like 1870, was remarkable for a great display of sun-spots. As in 1870, they were then visible to the naked eye. I well remember my own boyish excitement when, a few weeks before the eclipse of 1836, I discovered a spot upon the reddened face of the setting sun—a thing I had read about, and supposed that only great astronomers were privileged to see. The richness of this sun-spot period is strongly impressed on my memory by the fact that I continued painfully watching the dazzling sun, literally "watching and weeping," up to the Sunday of the eclipse, on which day also I saw a large spot through my bit of smoked glass.

The previous records of these appearances of fracture of the thin line of light are those of Halley, in his memoir on the total eclipse of 1715, and Maclauren's on that of 1737. Both of these correspond to great spot periods; the intervals between 1715, 1737, 1836, and 1870 are all divisible by eleven. The observed period of sun-spot occurrence is eleven years and a small fraction.

I am anxiously awaiting the arrival of Lord Lindsay's long-exposure photographs of the corona, for if they represent the varying degrees of splendor of this solar appendage, the explanations offered in Chapter xii. of my essay on "The Fuel of the Sun" will be very severely tested by them.

Yours respectfully,

W. Mattieu Williams.

Woodside Green, Croydon, January 4, 1871.

THE COLORING OF GREEN TEA.

The following is a copy of my report to the *Grocer* on a sample of the ingredients actually used by the Chinese for coloring of tea, which sample was sent to the *Grocer* office by a reliable correspondent at Shanghai (November, 1873). I reprint it because the subject has a general interest and is commonly misunderstood:

I have examined the blue and the yellowish-white powders received from the office, and find that the blue is not indigo, as your Shanghai correspondent very naturally supposes, but is an ordinary commercial sample of Prussian blue. It is not so bright as some of our English samples, and by mere casual observation may easily be mistaken for indigo. Prussian blue is a well-known compound of iron, cyanogen, and potassium. Commercial samples usually contain a little clayey or other earthy impurities, which is the case with this Chinese sample. There are two kinds of Prussian blue — the insoluble, and the basic or soluble. The Chinese sample is insoluble.

This is important, seeing that we do not eat our tea-leaves, but merely drink an infusion of them; and thus even the very small quantity which faces the tea-leaf remains with the spent leaves, and is not swallowed by the tea-drinker, who therefore need have no fear of being poisoned by this ornamental adulterant.

Its insolubility is obvious, from the fact that green tea does not give a blue infusion, which would be the case if the Prussian blue were dissolved.

There are some curious facts bearing on this subject and connected with the history of the manufacture of Prussian blue. Messrs. Bramwell, of Newcastle-on-Tyne, who may be called the fathers of this branch of industry, established their works about a century ago. It was first sold at two guineas per lb.; in 1815 it had fallen to 10*s.* 6*d.*, in 1820 to 2*s.* 6*d.*, then down to 1*s.* 9*d.* in 1850. I see by the Price Current of the *Oil Trade Review* that the price has recently been somewhat higher.

In the early days of the trade a large portion of Messrs. Bramwell's produce was exported to China. The Chinese then appear to have been the best customers of the British manufacturers of this article. Presently, however, the Chinese demand entirely ceased, and it was discovered that a common Chinese sailor, who had learned something of the importation of this pigmet to his native country, came to England in an East Indiaman, visited, or more probably obtained employment at a Prussian blue manufactory, learned the process, and, on his return to China, started there a manufactury of his own, which was so successful that in a short time the whole of the Chinese demand was supplied by native manufacture; and thus ended our export trade. Those who think the Chinese are an unteachable and unimprovable people may reflect on this little history.

The yellowish powder is precisely what your Shanghai correspondent supposes. It is steatite, or "soapstone." This name is very deceptive, and coupled with the greasy or unctuous feel of the substance, naturally leads to the supposition that it is really as it appears, an oleaginous substance. This, however, is not the case. It is a compound of silicia, magnesia, and water, with which are sometimes associated a little clay and oxide of iron. Like most magnesian minerals, it has a curiously smooth or slippery surface, and hence its name. It nearly resembles meerschaum, the smoothness of which all smokers understand.

When soapstone is powdered and rubbed over a moderately rough surface, it adheres, and forms a shining film; just as another unctuous mineral, graphite (the "black-lead" of the housemaid), covers and polishes ironwork. On this account, soapstone is used in some lubricating compounds, for giving the finishing polish to enameled cards, and for other similar purposes.

With a statement of these properties before us, and the interesting description of the process by your Shanghai correspondent, the whole riddle of green-tea coloring and facing is solved. The Prussian blue and soapstone being mixed together when dry in the manner described, the soapstone adheres to the surface of the particles of blue, and imparts to them not only a pale greenish color, but also its own unctuous, adhesive, and polishing properties. The mixture being well stirred in with the tea-leaves, covers them with this facing, and thus gives both the color and peculiar pearly lustre characteristic of some kinds of green tea. I should add that the soopstone, like the other ingredient, is insoluble, and therefore perfectly harmless.

Considering the object to be attained, it is evident from the above that John Chinaman understands his business, and needs no lessons from European chemists. It would puzzle all the Fellows of the Chemical Society, though they combined their efforts for the purpose, to devise a more effective, cheap, simple, and harmless method of satisfying the foolish demand for unnaturally colored tea-leaves.

When the tea-drinking public are sufficiently intelligent to prefer naturally colored leaves to the ornamental stuff they now select, Mr. Chinaman will assuredly be glad enough to discontinue the addition of the Prussian blue, which costs him so much more per pound than his tea-leaves, and will save him the trouble of the painting and varnishing now in demand.

In the meantime, it is satisfactory to know that, although a few silly people may be deceived, nobody is poisoned by this practice of coloring green tea. I say "a few silly people," for there can be only a few, and those very silly indeed, who judge of their tea by its appearance rather than by the quality of the infusion it produces.

With these facts before us it is not difficult to trace the origin of the oft-repeated and contradicted statement that copper is used in coloring green tea. One of the essential ingredients in the manufacture of Prussian blue is sulphate of iron, the common commercial name which is "green copperas." It is often supposed to contain copper, but this is not the case.

Your Shanghai correspondent overrates the market value of soapstone when he supposes that Chinese wax may be used as a cheap substitute. In many places—as, for instance, the "Lizard" district of Cornwall—great veins of this mineral occur, which, if needed, might be quarried in vast abundance, and at very little cost on account of its softness. The romantic scenery of Kynance Cove, its caverns, its natural arches, the "Devil's Bellows," the "Devil's Post-office," the "Devil's Cauldrons," and other fantastic formations of this part of the coast, attributed to his Satanic Majesty or the Druids, are the natural results of the waves beating away the veins of soft soapstone, and leaving the deformed skeleten rocks of harder serpentine behind.

"IRON FILINGS" IN TEA.

I HAVE watched the progress of the tea controversy and the other public performances of the public analysts with considerable interest; it might have been with amusement, but for the melancholy degradation of chemical science which they involve.

Among the absurdities and exaggerations which for some years past have been so industriously trumpeted forth by the pseudo-chemists who trade upon the adulteration panic and consequent demand for chemical certificates of purity, the continually repeated statements concerning the use of iron filings as a fraudulent adulterant of tea take a prominent place. I need scarcely remark that, in order to form such an adulterant, the quantity added must be sufficiently great to render its addition commercially profitable to an extent commensurate with the trouble involved.

The gentlemen who, since the passing of the Adulteration Act, have by some kind of inspiration suddenly become full-blown chemists, have certified to wilful adulteration of tea with iron filings, and have obtained *convictions* on such certificates, when, according to their own statement, the quantity contained has not exceeded 5 per cent in the cheapest qualities of tea. Now, the price of such tea to the Chinaman tea-grower, who is supposed to add these iron filings, is about fourpence to sixpence per pound; and we are asked to believe that he will fraudulently deteriorate the market value of his commodity for the sake of this additional 1-20th of weight. Supposing that he could obtain his iron filings at twopence per pound, his total gain would thus be about 1-10th of a penny per pound. But can he obtain such iron filings in the quantity required at such a price? A little reflection on a few figures will render it evident that he cannot, and that such adulteration is utterly impossible.

I find by reference to *The Grocer* of November 8th, that the total deliveries of tea into the port of London during the first ten months of 1872 were 142,429,337 lbs., and during the corresponding period of 1873, 139,092,409 lbs. Of this about 8½ millions of pounds in 1873, and 10 millions of pounds in 1872, were green, the rest black. This gives in round numbers about 160 millions of pounds of black tea per annum, of which above 140 millions come from China. As the Russians are greater tea-drinkers than ourselves—the Americans and British colonists are at least equally addicted to the beverage, and other nations consume some quantity—the total exports from China may be safely estimated to reach 400 or 500 millions of pounds.

Let us take the smaller figure, and suppose that only one fourth of this is adulterated, to the extent of 5 per cent, with iron filings. How much would be required? Just five millions of pounds per annum.

It must be remembered that *coarse* filings could not possibly be used; they would show themselves at once to the naked eye as rusty lamps, and would shake down to the bottom of the chest; neither could borings, nor turnings, nor plane-shavings be used. Nothing but *fine* filings would answer the supposed purpose. I venture to assert that if the China tea-growers were to put the whole world under contribution for their supposed supply of fine iron filings, this quantity could not be obtained.

Let anyone who doubts this borrow a blacksmith's vice, a fine file, and a piece of soft iron, then take off his coat and try how much labor will be required to produce a single ounce of filings, and also bear in mind that fine files are but very little used in the manufacture of iron. As the price of a commodity rises when the demand exceeds the supply the Chinaman would have to pay far more for his adulterant than for the leaves to be adulterated. As Chinese tea-growers are not public analysts, we have no right to suppose that they would perpetrate any such foolishness.

The investigations recently made by Mr. Alfred Bird, of Birmingham, show that the iron found in tea-leaves is not in the metallic state, but in the condition of oxide; and he confirms the conclusions of Zöller, quoted by Mr. J. A. Wanklyn in the *Chemical News* of October 10th—viz., that compounds of iron naturally exist in genuine tea. It appears, however, that the ash of many samples of *black* tea contains more iron than naturally belongs to the plant; and, accepting Mr. Bird's statement, that this exists in the leaf as oxide mixed with small siliceous and micaceous particles I think we may find a reasonable explanation of its presence without adopting the puerile theory of the adulteration maniac, who, in his endeavor to prove that everybody who buys or sells anything is a swindler, has at once assumed the impossible addition of iron filings as a makeweight.

In the first place we must remember that the commodity in demand is *black* tea, and that ordinary leaves dried in an ordinary manner are not black, but brown. Tea-leaves, however, contain a large quantity of tannin, a portion of which is, when heated in the leaves, rapidly convertible into gallo-tannic or tannic acid. Thus a sample of tea rich in iron would, when heated in the drying process, become, by the combination of this tannic acid with the iron it contains, much darker than ordinary leaves or than other teas grown upon less ferruginous soils and containing less iron.

This being the case, and a commercial demand for *black* tea having become established, the tea-grower would naturally seek to improve the color of his tea, especially of those samples naturally poor in iron, and a ready mode of doing this is offered by stirring in among the leaves while drying a small additional dose of oxide of iron, if he can find an oxide in such a form that it will spread over the surface of the leaf as a thin film. Now, it happens that the Chinaman has lying under his feet an abundance of material admirably adapted for this purpose—viz., red hæmatite, some varieties of which are as soft and unctuous as graphite, and will spread over his tea-leaves exactly in the manner required. The micaceous and siliceous particles found by Mr. Bird are just what should be found in addition to oxide of iron, if such hæmatite were used.

The film of oxide thus easily applied, and subjected to the action of the exuding and decomposing extractive matter of the heated leaves, would form the desired black dye or "facing."

The knotty question of whether this is or is not an adulteration is one that I leave to lawyers to decide, or for those debating societies that discuss such interesting questions as whether an umbrella is an article of dress. If it is an adulteration, and, as already admitted, is not at all injurious to health, then all other operations of dyeing are also adulterations; for the other dyers, like the Chinaman, add certain impurities to their goods—the silk, wool, or cotton—in order to alter their natural appearance, and to give them the false facing which their customers demand, but with this difference, if I am right in the above explanation: that in darkening tea nothing more is done but to increase the proportion of one of its natural ingredients, and to intensify its natural color; while in the dyeing of silk, cotton, or wool, ingredients are added which are quite foreign and unnatural, and the natural color of the substance is altogether falsified.

The above appeared in the *Chemical News* November 21, 1873, when the adulteration in question was generally believed to be commonly perpetrated, and many unfortunate shop-keepers had been and were still being summoned to appear at Petty Sessions, etc., and publicly branded as fraudulent adulterators on the evidence of the newly-fledged public analysts, who confidently asserted that they found such filings mixed with the tea. Some discussion followed in subsequent numbers of the *Chemical News;* but it only brought out the fact that "finely divided iron" exists in considerable quantities in Sheffield,—may be "begged," as Mr. Alfred H. Allen (an able analytical chemist, resident in Sheffield,) said. The fact that such finely divided iron is thus without commercial value still further confirms my conclusion that it is not used for the adulteration of tea. If it were, its collection would be a regular business, and truck-loads would be transmitted from Sheffield to London, the great centre of tea-importation. No evidence of any commercial transactions in iron filings or iron dust for such purposes came forward in reply to my challenge.

The practical result of the controversy is that iron filings are no longer to be found in the analytical reports of the adulteration of tea.

CONCERT-ROOM ACOUSTICS.

The acoustics of public buildings are now occupying considerable attention in London. The vast audiences which any kind of sensational performance in the huge metropolis is capable of attracting, is forcing the subject upon all who cater for public amusement or instruction. There was probably no building in London, or anywhere else, more utterly unfit for musical performances than the Crystal Palace in its original condition; but, nevertheless, the Handel Festival of last week was a great success. I attended the first of these immense gatherings, and this last; but nothing of the kind intermediate, and, therefore, am the better able to make comparisons.

My recollections of the first were so very unsatisfactory that I gladly evaded the grand rehearsal of Friday week, and went to the "Messiah" on Monday with an astronomical treatise in my pocket, in order that my time should not be altogether wasted. Being seated at the further end of the transept, in a gallery above the level of the general ridge-and-furrow roof of the nave, the plump little Birmingham tenor, who rose to sing the first solo, appeared, under the combined optical conditions of distance and vertical foreshortening, like a chubby cheese-mite viewed through a binocular microscope. Taking it for granted that his message of comfort could not possibly reach my ear, I determined to anticipate the exhortation by settling down for a comfortable reading of a chapter or two, but was surprised to find I could hear every note, both of recitative and air.

It thus became obvious that the alterations that have gradually grown since the time when Clara Novello's voice was the only one that could be heard across the trancept are worthy of study; that the advertised success of the "velarium" is something more than mere puffery. I accordingly used my eyes as well as my ears, and made a few notes which may be interesting to musical and architectural, as well as to scientific readers.

Sound, like light, heat, and all other radiations, loses its intensitp as it is outwardly dispersed, is enfeebled in the ratio of the squares of distance; thus at twenty feet from the singer the loudness of the sound is one fourth of that at ten feet, at thirty feet one ninth, at forty feet one sixteenth, at fifty feet one twenty-fifth, and so on; that is, supposing the singer or other source of sound is surrounded on all sides by free, open, and still air.

But this condition is never fulfilled in practice, excepting, perhaps, by Simeon Stylites when he preached to the multitude from the top of his column. If Mr. Vernon Rigby had stood on the top of one of his native South Staffordshire chimney-shafts, of the same height above the ground as the upper press gallery of the Crystal Palace is above the front of the orchestra, and I had stood on the open ground at the same distance away and below him, his solo of "Comfort ye, my People" would have been utterly inaudible.

What, then, is the reason of this great difference of effect at equal distances? If we can answer this question, we shall know something about the acoustics of concert-rooms.

The uninitiated reader will at one begin by saying that "sound rises." This is almost universally believed, and yet it is a great mistake, as commonly understood. Sound radiates equally in every direction—downwards, upwards, north, south, east, or west, unless some special directive agency is used. The directive agency commonly used is a reflecting or reverberating surface.

Thus the voice of the singer travels forward more abundantly than backward, because he uses the roof, and, to some extent, the walls and floor of his mouth, as a sound reflector. The roof of his mouth being made of concave plates of bone with a thin velarium of integument stretched tightly over them, supplies a model sound reflector; and I strongly recommend every architect who has to build a concert or lecture-room, or theatre, to study the roof of his own mouth, and imitate it as nearly as he can in the roof of his building.

The great Italian singing masters of the old school, who, like the father of Persiani, could manufacture a great voice out of average raw material, studied the physiology of the vocal organs, and one of their first instructions to their pupils was that they should sing against the roof of the mouth, then throw the head back and open the mouth, so that the sound should reverberate forwards, clear of the teeth and lips. For the first year or two the pupil had to sing only "la, la," for several hours per day, until the faculty of doing this effectually and habitually was acquired.

The popular notion that sound rises has probably originated from the fact that in our common experience the sounds are produced near to some kind of floor, which reflects the sounds upwards, and thus adds the reflected sound to that which is directly transmitted, and thereby the general result is materially augmented.

But if we would economize sound most effectively, we must have not only a reflecting floor, but also a reflecting roof and reflecting walls on all sides of the concert room. These are the conditions that were wanting in the original structure of the Crystal Palace transept, for then the sound of the singer's voice could travel upwards to that lofty arch and sidewise in all directions, almost as freely as in the open air.

This defect has been remedied to a very great extent by the velarium stretched across from the springing of the great arch of glass and iron, and forming a ceiling to the concert-room part of the building. Besides this, a wall of drapery is stretched across each side of the transept, and the orchestra has its special walls, roof, and back. There are other minor arrangements for effecting lateral reverberation; that is, for returning the sound into the auditorium proper instead of allowing it to wander feebly througout the building.

The general result of these arrangements is to render that portion of the building in which the reserved seats are placed a really luxurious and efficient concert-room, of magnificent proportions; but, very unfortunately and inevitably, these conditions, which are so favorable for the happy eight or nine thousand who can afford reserved seats, render the position of the other half-dozen thousand outsiders more disappointing and vexatious than ever. For my own part I would rather spend a holiday afternoon in the mild atmosphere and the quiet, soothing gloom of a coal-pit than be teased and irritated by a strained listening to the indefinite roar of a grand choir, and the occasional dying vibrations of Sims Reeves' "top A."

I have in the above advocated reverberation as a remedy for diffusion of sound. This may, perhaps, appear rather startling to some musicians who have a well-founded dread of echoes, and who read the words *echo* and *reverberation* as synonymous. This requires a little explanation. As light is transmitted, reflected, and absorbed in the same manner as sound, and as light is visible—or, rather, renders objects visible—I will illustrate my meaning by means of light.

Let us suppose three apartments of equal size and same shape, one having its walls covered with mirrors, the second with white paper, and the third with black woollen cloth, and all lighted with central chandeliers of equal brilliancy. The first and second will be much lighter than the third, but they will be illuminated very differently.

In the first, there will be a repetition of chandeliers in the mirrored walls, each wall definitely reflecting the image of each particular light. In the second room there will be reflection also, and economy of light, but no reflection of definite images; the apartment will appear to be filled with a general and well-diffused luminosity, rendering every object distinctly visible, and there will be no deep shadows anywhere.

In scientific language, we shall have, in the first room, *regular reflection;* in the second, *scattering reflection;* in the third room we should have comparative gloom, owing to the *absorption* of the light by the black cloth.

We may easily suppose the parallels of these in the case of sound. If the velarium and side walls of the transept and orchestra were made of sheet iron, or smooth, bare, unbroken vibrating wooden boards, we should have a certain amount of *regular* reflection of sound or echo. Just as we should see the particular lights of the chandelier reflected in the first room, so should we hear the particular notes of the singer or player echoed by such regularly vibrating walls and ceiling.

If, again, the velarium and side drapery of the transept and orchestra had been thick, soft woollen cloths, the sound, like the light, would have been absorbed or "muffled," and, though very clear, it would be weak and insufficient.

The reader will now ask—What, then, is the right material for such velarium and walls? I cannot pretend to say what is the best possible, believing that it has yet to be discovered. The best yet known, and attainable at moderate expense, is common canvas or calico, washed or painted over with a mixture of size and lime, or other attainable material that will fill up the pores of the fabric, and give it a moderately smooth face or surface. Thus prepared, it is found to reflect sound, as paper, ground glass, etc., reflect light, by scattering reverberation, but without definite echo.

It will now be understood how the velarium acted in rendering the solos so clearly audible at the great height and distance of the Upper Press Gallery. Instead of being wasted by diffusion in the great vault above, they were stopped and reflected by the velarium, but not so reflected as to produce disagreeable repetition notes, just audible at particular points, as the lights of the mirror reflections of the chandeliers would be.

Flat surfaces reflect radially, while concave surfaces with certain curves reflect sound, light, heat, etc., in parallel lines. The walls and roof of a music-hall should scatter their reflections on all sides, and, therefore, should be flat, or nearly so, excepting at the angles, which should be curved or hollowed. From the orchestra the sound is chiefly required to be projected forward as from the singer's mouth; and, therefore, an orchestra should have curved walls and roof.

Space will not permit a dissertation here on the particular curve required. This has, I believe, been carefully calculated in constructing the Crystal Palace orchestra. Viewed from a distance, the whole orchestra is curiously like a huge wide-opened mouth that only requires to close a little and open a little more, according to the articulations of the choir, to represent the vocal effort of one gigantic throat.

There is, I think, one fault in the shape of this mouth. It extends too far laterally in proportion to its perpendicular dimensions. The angles of the mouth are too acute; the choir extends too far on each side. The singers should be packed more like those of the Birmingham Festival Choir.

There is an acoustic limit to the magnitude of choirs. Sound travels at about 1100 feet per second, and thus, if one of the singers of a choir is 110 feet nearer than another singer to any particular auditor, the near singer will be heard one-tenth of a second before the more distant, though they actually sing exactly together. In rapid staccato passages this would produce serious confusion, though in such music as most of Handel's it would be scarcely observable.

Some observations which I have made convince me that the actual choir of the Handel Festivals has reached, if not exceeded, the acoustic limits even for Handel's music, and decidedly exceeds the limits permissible for Mendelsshon and most other composers.

I found that when standing on the floor of the building in front of the orchestra, and on one side, I could plainly distinguish the wave of difference of time due to the traveling of the sound, and in all the passages which required to be taken up smartly and simultaneously by the opposite sides of the choir, the effect was very disagreeable.

The defect, however, was not observable from the press gallery, which is placed as nearly as may be to the focus of the orchestral curve, so that radial lines drawn from the auditor to different parts of the orchestra do not differ so much in length as to effect perceptible differences in the moment at which the different sounds reach the ear.

My conclusion, therefore, is that if any amendment is to be made in the numbers of the Handel Festival choir, it should rather be done by a reduction than an increase; that the four thousand voices should rather be reduced to three thousand than increased to five thousand. With greater severity of selection as regards quality, power, and training of each individual voice, and with better packing, the three thousand would be more effective than the four thousand.

SCIENCE AND SPIRITUALISM.

A RATHER startling paper in the current number of the "Quarterly Journal of Science," from the pen of William Crookes, F.R.S. (who is well known in the scientific world by his discovery of the metal thallium, his investigations of its properties and those of its compounds, besides many other important researches, and also as the able and spirited editor of the *Chemical News*), is now the subject of much scientific gossip and discussion.

Mr. Crookes has for some time past been engaged in investigating some of the phenomena which are attributed on one hand to the agency of spiritual visitors, and on the other side to vulgar conjuring. Nobody acquainted with Mr. Crookes can doubt his ability to conduct such an investigation, or will hesitate for a moment in concluding that he has done so with philosophical impartiality, though many think it quite possible that he may have been deceived. None, however, can yet say how.

For my own part, I abstain from any conclusion in the meantime, until I have time and opportunity to witness a repetition of some of these experiments, and submitting them to certain tests which appear to me desirable. Though struggling against a predisposition to prejudge, and to conclude that the phenomena are the results of some very skillful conjuring, I very profoundly respect the moral courage that Mr. Crookes has displayed in thus publicly grappling with a subject which has been soiled by contact with so many dirty fingers. Nothing but a pure love of truth, overpowering every selfish consideration, could have induced Mr. Crookes to imperil his hard-earned scientific reputation by stepping thus boldly on such very perilous ground.

It is only fair, at the outset, to state that Mr. Crookes is not what is called "a spiritualist." This I infer, both from what he has published and from conversation I have had with him on the subject. He has witnessed some of the "physical manifestations," and, while admitting that many of these may be produced by the jugglery of impostors, he has concluded that others cannot be thus explained; but, nevertheless, does not accept the spiritual theory which attributes them to the efforts of departed human souls.

He suspects that the living human being may have the power of exerting some degree of force or influence upon bodies external to himself—may, for instance, be able to counteract or increase the gravitation of substances by an effort of the will. He calls this power the "psychic force," and supposes that some persons are able to manifest it much more powerfully than others, and thus explains the performances of those "mediums" who are not mere impostors.

There is nothing in this hypothesis which the sternest, the most sceptical, and least imaginative of physical philosophers may not unhesitatingly investigate, provided some first-sight evidence of its possibility is presented to him. We know that the Torpedo, the Gymnotus, the Silurus Electricus, and other fishes, can, by an effort of the will, act upon bodies external to themselves. Faraday showed that the electric eel exhibited some years ago at the Adelaide Gallery was able, by an effort of its will, to make a magnetic needle suddenly turn thirty degrees aside from its usual polar position; that this same animal could—still by an effort of will—overpower the gravitation of pieces of gold leaf, cause them to be uplifted and outstretched from their pendent position, could decompose iodide of potassium, and perform many other "physical manifestations," simply by a voluntary nervous effort, and without calling in the aid of any souls of other departed eels.

Before this gymnotus was publicly exhibited it was deposited at a French hotel in the neighborhood of Leicester Square. A burly fishmonger's man, named Wren, brought in the daily supply of fish to the establishment, when some of the servants told him they had an eel so large that he would be afraid to pick it up. He laughed at the idea of being afraid of an eel, and when taken to the tub boldly plunged in both hands to seize the fish. A hideous roar followed this attempt. Wren had experienced a demonstration of the "psychic force" of the electrical eel, and his terror so largely exaggerated the actual violence of the shock, that he believed for the remainder of his life that he was permanently injured by it. He had periodical spasms across the chest, which could only be removed by taking a half-quartern of gin. As he was continually narrating his adventure to public-house audiences, and always had a spasm on concluding, which his hearers usually contributed to relieve, the poor fellow's life was actually shortened by the shock from the gymnotus.

The experiments which Mr. Crookes relates in support of his psychic force hypothesis are as follows:—In the first place he contrived an apparatus for testing Mr. Home's alleged power of modifying the gravitation of bodies. As Mr. Home requires to lay his hands, or at least his finger-ends, upon the body to be influenced, Mr. Crookes attached one end of a long board to a suspended spring steelyard of delicate construction; the other end of the board rested on a fulcrum in such a manner that one half of the weight of the board was supported by the fulcrum and the other half by the steelyard. The weight of the board thus suspended was carefully noted, and then Mr. Home put his fingers upon that end of the board immediately resting on the fulcrum in such a manner that he could not by simple pressure affect the dependent end of the board.

Dr. Huggins, the eminent astronomer, was present, and also Serjeant Cox, besides Mr. Crookes. They all watched Mr. Home, the board, and the steelyard; they observed first a vibration and fluctuation of the index, and finally that the steelyard indicated an increase of weight amounting to about three pounds. Mr. Crookes tried to produce the same effect by mechanical pressure exerted in a similar manner, but failed to do so. The details of the experiment are fully described and illustrated by an engraving.

Another and still more striking experiment is described. Mr. Crookes purchased a new accordion from Messrs. Wheatstone, and himself constructed a wire cage open at top and bottom, and large enough for the accordion to be suspended within it by holding it over the open top, while the bottom of the cage rested on the floor. The accordion was then handed to Mr. Home, who held it with one hand by the wooden framework of the bottom of the instrument, as shown in an illustrative drawing. The keys were thus hanging downwards and the bellows distended by the weight of the instrument thus pendent. It was then held so that it should be entirely surrounded by the wire-work of the cage, and the results were, as before, watched keenly by Mr. Crookes, Dr. Huggins, and Serjeant Cox. After a while the instrument began to wave about, then the bellows contracted, and the lower part (*i.e.*, the key-board end) rose a little, presently sounds were produced, and finally the instrument played a tune upon itself in obedience, as Mr. Crookes supposes, to the psychic force which Mr. Home exerted upon it.

Before the publication of the paper describing these experiments a proof was sent to both Dr. Huggins and Serjeant Cox, and each has written a letter testifying to its accuracy, which letters are printed with the paper in the "Quarterly Journal of Science."

Here, then, we have the testimony of an eminent lawyer, accustomed to sifting evidence, that of the most distinguished of experimental astronomers, the man whose discoveries in celestial physics have justly excited the admiration of the whole civilized world; and besides these, of another Fellow of the Royal Society, who has been severely trained in "putting nature to the torture" by means of the most subtle devices of the modern physical and chemical laboratory.

Such testimony must not be treated lightly. It would be simple impertinence for any man dogmatically to assert that these have been deceived merely because he is unconvinced.

Though one of the unconvinced myself, I would not dare to regard the investigations of these gentlemen with any other than the profoundest respect. Still a suggestion occurs to me which may appear very brutal, but I make it nevertheless. It is this:—That the testimony of another witness—of an expert of quite a different school—should have been added. I mean such a man as Döbler, Houdin, or the Wizard of the North. He might possibly have detected something which escaped the scrutiny of the legitimate scientific experimentalist.

There is one serious defect in the accordion experiment. The cage is represented in the engraving as placed under a table; Mr. Home holds the instrument in his hand, which is concealed by the table, and it does not appear that either Mr. Crookes, Dr. Huggins, or Serjeant Cox placed themselves under the table during the concertina performance, and thus neither of them saw Mr. Home's hand. Such, at least, appears from the description and the engraving. A story being commonly circulated respecting some of Mr. Home's experiments in Russia, according to which he failed entirely when a glass table was provided instead of a wooden one, it would be well, if only in justice to Mr. Home, to get rid of the table altogether.

It is very desirable that these experiments should be continued, for two distinct reasons; first, as a matter of ordinary investigation for philosophical purposes, and, secondly, as a means of demolishing the most degrading superstition of this generation.

If Mr. Crookes succeeds in demonstrating the existence of the psychic force and reducing it to law—as it must be reducible if it is a force—then the ground will be cut from under the feet of spiritualism, just as the old superstitions, which attributed thunder and lightning to Divine anger, were finally demolished by Franklin's kite. If, on the other hand, the arch-medium, Mr. Home, is proved to be a common conjuror, then surely the dupes of the smaller "mediumistic" fry will have their eyes opened, provided the cerebral disturbance which spiritualism so often induces has not gone so far as to render them incurable lunatics.

It is very likely that I shall be accused of gross uncharitableness in thus applying the term lunatic to "those who differ from me," and therefore state that I have sad and sufficient reasons for doing so.

The first spiritualist I ever knew, and with whom I had many conferences on the subject many years ago, was a lady of most estimable qualities, great intellectual attainments, and distinguished literary reputation. I watched the beginning and the gradual progress of her spiritual "investigations," as she called them, and witnessed the melancholy end—shocking delusions, intellectual shipwreck, and confirmed, incurable insanity, directly and unmistakably produced by the action of these hideous superstitions upon an active, excitable imagination.

I well remember the growing symptoms of this case, have seen their characteristic features repeated in others, and have now before me some melancholy cases where the same changes, the same decline of intellect and growth of ravenous credulity, is progressing with most painfully visible distinctness.

The necessity for some strong remedy is the more urgent, inasmuch as the diabolical machinery of the spiritual impostors has been so much improved of late. The lady whose case I first referred to had reached the highest stage of spiritualistic development—viz., the lunatic asylum—before "dark séances" had been invented, or, at any rate, before they were introduced into this country. When the conditions of these séances are considered, it is not at all surprising that persons of excitable temperament, especially women, should be morbidly affected by them.

We are endowed with certain faculties, and placed in a world wherein we may exercise them healthfully upon their legitimate objects. Such exercise, properly limited, promotes the growth and vigor of our faculties; but if we pervert them by directing them to illegitimate objects, we gradually become mad. God has created the light, and fitted our eyes to receive it; He has endowed us with the sense of touch, by which we may confirm and verify the impressions of sight. All physical phenomena are objects of sense, and the senses of sight and touch are the masters of all the other senses.

Can anything, then, be more atrociously perverse, more utterly idiotic, and I may even say impious, than these dark séance investigations? Is it possible to conceive a more melancholy spectacle of intellectual degradation than that presented by a group of human victims assembled for the purpose of "investigating physical manifestations," and submitting, as a primary condition, to be blinded and handcuffed, the room in which they sit being made quite dark, and both hands of each investigator being firmly held by those of his neighbors. That is to say, the primary conditions of making these physical investigations is that each investigator shall be deprived of his natural faculties for doing so.

When we couple this with the fact that these meetings are got up—publicly advertised by adventurers who make their livelihood by the fees paid by their hoodwinked and handcuffed customers—is it at all surprising that those who submit to such conditions should finish their researches in a lunatic asylum?

The gloom, the mystery, the unearthly objects of search, the mysterious noises, and other phenomena so easily manipulated in the presence of those who can see nothing and feel only the sympathetic twitching of another pair of trembling hands, naturally excites very powerfully the poor creatures who pay their half-crowns and half-guineas with any degree of faith; and this unnatural excitement, if frequently repeated, goes on increasing till the brain becomes incurably diseased.

Present space will not permit me to enter upon another branch of this subject, viz.: the moral degradation and the perversion of natural, unsophisticated, and wholesome theology, which these spiritual delusions are generating.

I am no advocate for rectifying moral and intellectual evils by police interference, or I should certainly recommend the bracing air of Dartmoor for the mediums who publicly proclaim that their familiar spirit "Katey" has lately translated a lady through a space of three miles, and through the walls, doors, and ceiling of the house in which a dark séance was being held, and placed her upon the table in the midst of the circle so rapidly that the word "onions" she had just written in her domestic inventory was not yet dried when the lights were brought and she was found there.

This "lady," which her name is Guppy, is, of course, another professional medium, and yet there are people in London who gravely believe this story, and also the appendix, viz.: that another member of the mediumistic firm, finding that Mrs. G. was very incompletely dressed, and much abashed thereby, was translated by the same spirit, Katey, to her house and back again through the door-panel to fetch proper garments. If I could justify the apprehension and imprisonment of poor gipsy fortune-tellers, I certainly should advocate the close confinement of Mrs. Guppy and her male associates, and thus afford the potent spirit, Katey, an opportunity of further manifestation by translating them through the prison walls and back to Lamb's Conduit Street.

(*The above letter appeared in the "Birmingham Morning News" of July* 18, 1871; *the following on November* 15. *It refers to an article in the "Quarterly Review" of October*, 1871.)

The interest excited by Mr. Crookes's investigations on Psychic Force is increasing; the demand for the "Quartely Review" and the "Quarterly Journal of Science" is so great that Mudie and other proprietors of lending libraries have largely increased their customary supplies, and are still besieged with further excess of demand. Not only borrowers, but purchasers also are supplied with difficulty. I yesterday received a post-card from a bookseller, inscribed as follows: "Cannot get a 'Quarterly Review' in the City, so shall be unable to send it to you until to-morrow." I have waited three days, and am now obliged to go to the reading-room to make my quotations.

There is good and sufficient reason for this, independently of the absence of Parliamentary and war news, and the dearth of political revolutions. Either a new and most extraordinary natural force has been discovered, or some very eminent men specially trained in rigid physical investigation have been the victims of a marvelous, unprecedented, and inexplicable physical delusion. I say unprecedented, because, although we have records of many popular delusions of similar kind and equal magnitude, and speculative delusions among the learned, I can cite no instance of skillful experimental experts being utterly and repeatedly deceived by the mechanical action of experimental test apparatus carefully constructed and used by themselves.

As the interest in the subject is rapidly growing, my readers will probably welcome a somewhat longer gossip on this than I usually devote to a single subject.

Such an extension is the more demanded as the newspaper and magazine articles which have hitherto appeared have, for the most part, by following the lead of the "Quarterly Review," strangely muddled the whole subject, and misstated the position of Mr. Crookes and others. In the first place, all the writers who follow the "Quarterly" omit any mention or allusion to Mr. Crookes's preliminary paper published in July, 1870, which has a most important bearing on the whole subject, as it expounds the object of all the subsequent researches.

Mr. Crookes there states that "Some weeks ago the fact that I was engaged in investigating Spiritualism, so-called, was announced in a contemporary (the "Athenæum"), and in consequence of the many communications I have since received, I think it desirable to say a little concerning the investigations which I have commenced. Views or opinions I cannot be said to possess on a subject which I do not profess to understand. I consider it the duty of scientific men, who have learned exact modes of working, to examine phenomena which attract the attention of the public, in order to confirm their genuineness, or to explain, if possible, the delusions of the honest, and to expose the tricks of the deceivers."

He then proceeds to state the case of Science *versus* Spiritualism thus:—"The Spiritualist tells of bodies weighing 50 or 100 lbs. being lifted up into the air without the intervention of any known force; but the scientific chemist is accustomed to use a balance which will render sensible a weight so small that it would take ten thousand of them to weigh one grain; he is, therefore, justified in asking that a power, professing to be guided by intelligence, which will toss a heavy body to the ceiling, shall also cause his delicately-poised balance to move under test conditions." "The Spiritualist tells of rooms and houses being shaken, even to injury, by superhuman power. The man of science merely asks for a pendulum to be sent vibrating when it is in a glass-case, and supported on solid masonary." "The Spiritualist tells of heavy articles of furniture moving from one room to another without human agency. But the man of science has made instruments which will divide an inch into a million parts, and he is justified in doubting the accuracy of the former observations, if the same force is powerless to move the index of his instrument one poor degree." "The Spiritualist tells of flowers with the fresh dew on them, of fruit, and living objects being carried through closed windows, and even solid brick walls. The scientific investigator naturally asks that an additional weight (if it be only the 1000th part of a grain) be deposited on one pan of his balance when the case is locked. And the chemist asks for the 1000th part of a grain of arsenic to be carried through the sides of a gas tube in which pure water is hermetically sealed."

These and other requirements are stated by Mr. Crookes, together with further exposition of the principles of strict inductive investigation, as it should be applied to such an inquiry. A year after this he published an account of the experiments, which I described in a former letter, and added to his own testimony that of the eminent physicist and astronomer, Dr. Huggins and Serjeant Cox. Subsequently, that is, in the last number of the "Quarterly Journal of Science," he has published the particulars of another series of experiments.

I will not now enter upon the details of these, but merely state that the conclusions of Mr. Crookes are directly opposed to those of the Spiritualists. He positively, distinctly, and repeatedly repudiates all belief in the operations of the supposed spirits, or of any other supernatural agency whatever, and attributes the phenomena he witnessed to an entirely different organ, viz.: to the direct agency of the medium. He supposes that a force analogous to that which the nerves convey from their ganglionic centres to the muscles, in producing muscular contraction, may by an effort of the will be transmitted to external inanimate matter, in such a manner as to influence, in some degree, its gravitating power, and produce vibratory motion. He calls this the *psychic force.*

Now, this is direct and unequivocal *anti*-spiritualism. It is a theory set up in opposition to the supernatural hypotheses of the Spiritualists, and Mr. Crookes's position in reference to Spiritualism is precisely analogous to that of Faraday in reference to table-turning. For the same reasons as those above-quoted, the great master of experimental investigation examined the phenomena called table-turning, and he concluded that they were due to muscular force, just as Mr. Crookes concludes that the more complex phenomena he has examined are due to psychic force.

Speaking of the theories of the Spiritualists, Mr. Crookes, in his first paper (July, 1870), says: "The pseudo-scientific Spiritualist professes to know everything. No calculations trouble his serenity; no hard experiments, no laborious readings; no weary attempts to make clear in words that which has rejoiced the heart and elevated the mind. He talks glibly of all sciences and arts, overwhelming the inquirer with terms like 'electro-biologise,' 'psychologise,' 'animal magnetism,' etc., a mere play upon words, showing ignorance rather than understanding." And further on he says: "I confess that the reasoning of some Spiritualists would almost seem to justify Faraday's severe statement—that many dogs have the power of coming to more logical conclusions."

I have already referred to the muddled misstatement of Mr. Crookes's position by the newspaper writers, who almost unanimously describe him and Dr. Huggins as two distinguished scientific men who have recently been converted to Spiritualism. The above quotations, to which, if space permitted, I might add a dozen others from either the first, the second, or the third of Mr. Crookes's papers, in which he as positively and decidedly controverts the dreams of the Spiritualists, will show how egregiously these writers have been deceived. They have relied very naturally on the established respectability of the "Quarterly Review," and have thus deluded both themselves and their readers. Considering the marvelous range of subjects these writers have to treat, and the acres of paper they daily cover, it is not surprising that they should have been thus misled in reference to a subject carrying them considerably out of their usual track; but the offence of the "Quarterly" is not so venial. It assumes, in fact, a very serious complexion when further investigated.

The title of the article is "Spiritualism and its Recent Converts," and the "recent converts" most specially and prominently named are Mr. Crookes and Dr. Huggins. Serjeant Cox is also named, but not as a *recent* convert; for the reviewer describes him as an old and hopelessly infatuated Spiritualist. Knowing nothing of Serjeant Cox, I am unable to say whether the reviewer's very strong personal statements respecting him are true or false—whether he really is "one of the most gullible of the gullible," etc., though I must protest against the bad taste which is displayed in the attack which is made upon this gentleman. The head and front of his offending consists in having certified to the accuracy of certain experiments; and for having simply done this, the reviewer proceeds, in accordance with the lowest tactics of Old Bailey advocacy, to bully the witness, and to publish disparaging personal details of what he did twenty-five years ago.

Dr. Huggins, who has had nothing further to do with the subject than simply to state that he witnessed what Mr. Crookes described, and who has not ventured upon one word of explanation of the phenomena, is similarly treated.

The reviewer goes out of his way to inform the public that Dr. Huggins is, after all, only a brewer, by artfully stating that, "like Mr. Whitbread, Mr. Lassell, and other brewers we could name, Dr. Huggins attached himself in the first place to the study of astronomy." He then proceeds to sneer at "such scientific amateurs," by informing the public that they "labor, as a rule, under a grave disadvantage, in the want of that broad basis of scientific culture which alone can keep them from the narrowing and pervertive influence of a limited *specialism.*"

The reviewer proceeds to say that he has "no reason to believe that Dr. Huggins constitutes an exception" to this rule, and further asserts that he is justified in concluding that Dr. Huggins is ignorant of "every other department of science than *the small subdivision of a branch* to which he has so meritoriously devoted himself." Mark the words, "small subdivision of a branch." Merely a twig of the tree of science is, according to this most unveracious writer, all that Dr. Huggins has ever studied.

If a personal vindication were the business of this letter I could easily show that these statements respecting the avocations, the scientific training, and actual attainments of Dr. Huggins are gross and atrocious misrepresentations; but Dr. Huggins has no need of my championship; his high scientific position, the breadth and depth of his general attainments, and the fact that he is not Huggins the brewer, are sufficiently known to all in the scientific world, with the exception of the "Quarterly" reviewer.

My object is not to discuss the personal question whether book-making and dredging afford better or worse training for experimental inquiry than the marvelously exact and exquisitely delicate manipulations of the modern observatory and laboratory, but to protest against this attempt to stop the progress of investigation, to damage the true interests of science and the cause of truth, by throwing low libellous mud upon any and everybody who steps at all aside from the beaten paths of ordinary investigation.

The true business of science is the discovery of truth; to seek it wherever it may be found, to pursue it through byeways as well as highways, and, having found it, to proclaim it plainly and fearlessly, without regard to authority, fashion, or prejudice. If, however, such influential magazines as the "Quarterly Review" are to be converted into the vehicles of artful and elaborate efforts to undermine the scientific reputation of any man who thus does his scientific duty, the time for plain speaking and vigorous protest has arrived.

My readers will be glad to learn that this is the general feeling of the leading scientific men of the metropolis; whatever they may think of the particular investigations of Mr. Crookes, they are unanimous in expressing their denunciations of this article.

The attack upon Mr. Crookes is still more malignant than that upon Dr. Huggins. Speaking of Mr. Crookes's fellowship of the Royal Society, the reviewer says: "We speak advisedly when we say that this distinction *was conferred on him with considerable hesitation;*" and further that "We are assured, on the highest authority, that he is regarded among chemists as a specialist of specialists, *being totally destitute of any knowledge of chemical philosophy, and utterly untrustworthy as to any inquiry which requires more than technical knowledge for its successful conduct.*"

The italics in these quotations are my own, placed there to mark certain statements to which no milder term than that of falsehood is applicable. The history of Mr. Crookes's admission to the Royal Society will shortly be published, when the impudence of the above statement respecting it will be unmasked; and the other quotations I have emphasized are sufficiently and abundantly refuted by Mr. Crookes's published works, and his long and able conduct of the *Chemical News*, which is the only and the recognized British periodical representative of chemical science.

If space permitted, I could go on quoting a long series of misstatements of matters of fact from this singularly unveracious essay. The writer seems conscious of its general character, for, in the midst of one of his narratives, he breaks out into a foot-note, stating that "*This* is not an invention of our own, but a fact communicated to us by a highly intelligent witness, who was admitted to one of Mr. Crookes's *séances*." I have taken the liberty to emphasize the proper word in this very explanatory note.

The full measure of the injustice of prominently thrusting forward Dr. Huggins and Mr. Crookes as "recent converts" to Spiritualism will be seen by comparing the reviewer's own definition of Spiritualism with Mr. Crookes's remarks above quoted. The reviewer says that "The fundamental tenet of the Spiritualist is the old doctrine of communication between the spirits of the departed and souls of the living."

This is the definition of the reviewer, and his logical conclusion is that Mr. Crookes is a Spiritualist because he explicitly denies the fundamental tenet of Spiritualism, and Dr. Huggins is a Spiritualist because he says nothing whatever about it.

If examining the phenomena upon which the Spiritualist builds his "fundamental tenet," and explaining them in some other manner, constitutes conversion to Spiritualism, then the reviewer is a far more thoroughgoing convert than Mr. Crookes, who only attempts to explain the mild phenomena of his own experiments, while the reviewer goes in for everything, including even the apotheosis of Mrs. Guppy and her translation through the ceiling, a story which is laughed at by Mr. Crookes and everybody else, excepting a few of the utterly crazed disciples of the "Lamb's Conduit Mediums" and the "Quarterly" reviewer, who actually attempts to explain it by his infallible and ever applicable physiological nostrum of *"unconscious cerebration."*

No marvelous story either of ancient or modern date is too strong for this universal solvent, which according to the reviewer, is the sole and glorious invention of Dr. Carpenter. Space will not now permit me to further describe "unconscious cerebration" and its vast achievements, but I hope to find a corner for it hereafter.

I may add that the name of the reviewer is kept a profound secret, and yet is perfectly well-known, as everybody who reads the article finds it out when he reaches those parts which describe Dr. Carpenter's important physiological researches and discoveries.

MATHEMATICAL FICTIONS.

(British Association, 1871.)

The President's inaugural address, which was going through the press in London while being spoken in Edinburgh, has already been subject to an unusual amount of sharp criticism. For my own part I cannot help regarding it as one of the least satisfactory of all the inaugural addresses that have yet been delivered at these annual meetings. They have been of two types, the historical and the controversial; the former prevailing. In the historical addresses the President has usually made a comprehensive and instructive survey of the progress of the whole range of science during the past year, and has dwelt more particularly on some branch which from its own intrinsic merits has claimed special attention, or which his own special attainments have enabled him to treat with the greatest ability and authority. A few President's have, like Dr. Huxley last year, taken up a particular subject only, and have discussed it more thoroughly than they could have done had they also attempted a general historical survey.

Every President until 1871 has scrupulously kept in view his judicial position, and the fact that he is addressing, not merely a few learned men, but the whole of England, if not the whole civilized world. They have therefore clearly distinguished between the established and the debatable conclusions of science, between ascertained facts and mere hypotheses, have kept this distinction so plainly before their auditors that even the most uninitiated could scarcely confound the one with the other.

In Sir William Thomson's address this desirable rule is recklessly violated. He tells his unsophisticated audience that Joule was able "to estimate the average velocity of the ultimate molecules or atoms" of gases, and thus determined the atomic velocity of hydrogen "at 6225 feet per second at temperature 60 degs. Fahr., and 6055 feet at the freezing point;" that "Clausius took fully into account the impacts of molecules upon one another, and the kinetic energy of *relative* motion of the matter constituting an individual atom;" and that "he investigated the relation between their diameters, the number in a given space, and the mean length of path from impact to impact, and so gave the foundation for estimates of the absolute dimensions of atoms." Also that "Loschmidt, in Vienna, had shown, and not much later Stoney, independently, in England, showed how to reduce from Clausius and Maxwell's kinetic theory of gases a superior limit to the number of atoms in a given measurable space."

The confiding auditor follows the President through further disquisitions on the "superlatively grand question, what is the inner mechanism of an atom?" and a minute and most definite description of the "regular elastic vibrations" of "the ultimate atom of sodium," of the manner in which "any atom of gas, when struck and left to itself, vibrates with perfect purity its fundamental note or notes," and how, "in a highly attenuated gas, each atom is very rarely in collision with other atoms, and therefore is nearly at all times in a state of true vibration," while "in denser gases each atom is frequently in collision;" besides, a great deal more, in all of which the existence of these atoms is coolly taken for granted, and treated as a fundamental established scientific fact.

After hearing all these oracular utterances concerning atoms, the unsophisticated listener before mentioned will be surprised to learn that no human being has ever seen an atom of any substance whatever; that there exists absolutely no direct evidence of the existence of any such atoms; that all these atoms of which Sir W. Thomson speaks so confidently and familiarly, and dogmatically, are pure fragments of the imagination.

He will be still further surprised to learn that the bare belief in the existence of ultimate atoms as a merely hypothetical probability is rejected by many of the most eminent of scientific men, and that among those who have disputed the idea of the atomic constitution of matter, is the great Faraday himself; that the question of the existence or non-existence of atoms has recently been rather keenly discussed; and that even on the question of the permissibility of admitting their *hypothetical* existence, scientific opinion is divided; and that such a confident assumption of their existence as forms the basis of this part of the President's address is limited to only a small section of mutually admiring transcendental mathematicians, Sir W. Thomson being the most admired among them, as shown by the address of Professor Tait to Section A.

It would have been perfectly legitimate and most desirable that Sir W. Thomson should give the fullest and most favorable possible statement of the particular hypotheses upon which he and his friends have exercised their unquestionably great mathematical skill; but he should have stated them as what they are, and for what they are worth, and have clearly distinguished between such hypotheses and the established facts of universally admitted science. Instead of doing this, he has so mixed up the actual discoveries of indisputable facts with these mere mathematical fancies as to give them both the semblance of equally authoritative scientific acceptance, and thus, without any intention to deceive anybody, must have misled nearly all the outside public who have heard or read his address.

As these letters are mainly intended for those who are too much engaged in other pursuits to study science systematically, and as most of the readers of such letters will, as a matter of course, read the inaugural address of the President of the British Association, I have accepted the duty of correcting among my own readers the false impression which this address may create.

As a set-off to the authoritative utterances of Sir W. Thomson on the subject of atoms, I quote the following from an Italian philosopher, who, during the present year, is holding in Italy a position very similar to that of the annual President of our British Association.

Professor Cannizzaro has been elected by a society of Italian chemists to act as this year's director of a Chronicle of the Progress of Chemical Science in Italy and abroad. In this capacity he has published an inaugural treatise on the history of modern chemical theory, in the course of which he thus speaks of the over-confident atomic theorists: "They often speak on molecular subjects with as much dogmatic assurance as though they had actually realized the ingenious fiction of Laplace—had constructed a microscope by which they could detect the molecules, and observe the number, forms, and arrangements of their constituent atoms, and even determine the direction and intensity of their mutual actions. Many of these things, offered at what they are worth—that is, as hypotheses more or less probable, or as simple artifices of the intellect—may serve, and really have served, to collocate facts and incite to further investigations which, one day or other, may lead to a true chemical theory; but, when perverted by being stated as truths already demonstrated, they falsify the intellectual education of the students of inductive science, and bring reproach on the modern progress of chemistry."

I translate the above from the first page of the first number of the "Gazetta Chimica Italiana," published at Palermo in January last. Had these words been written in Edinburgh on the evening of the 2d of August, in direct application to Sir William Thomson's address, they could not have described more pointedly and truly the prevailing vice of this production. If space permitted, I could go further back and quote the words of Lord Bacon, from the great text-book of inductive philosophy, wherein he denounces the worship of all such intellectual idols as our modern mathematical dreamers have created, and which they so fervently adore.

An able writer in the *Daily News* of last Friday is very severe upon the biological portion of the President's address, which contains a really original hypothesis. Sir W. Thomson having stated that he is "ready to adopt as an article of scientific faith, true through all space and through all time, that life proceeds from life, and from nothing but life," asks the question, "How then did life originate on the earth?" and tells us that "if a probable solution consistent with the ordinary course of nature can be found, we must not invoke an abnormal act of creative power."

He assumes, with that perfect confidence in mathematical hypotheses which is characteristic of the school of theorists which he leads, that "tracing the physical history of the earth backwards, on strictly dynamical principles, we are brought to a red-hot melted globe, on which no life could exist;" and then, to account for the beginning of life on our earth as it cooled down, he creates another imaginary world, which he brings in collision with a second similar creation, and thereby shatters it to fragments. He further imagines that one of these imaginary broken-up worlds was already stocked with the sort of life which he says can only proceed from life, and that from such a world thus stocked and thus smashed "many great and small fragments carrying seed and living plants and animals would undoubtedly be scattered through space;" and that, "if at the present instant no such life existed upon this earth, one such stone falling upon it might, by what we blindly call *natural* causes, lead to its becoming covered with vegetation."

The conclusion of this paragraph is instructively characteristic of the philosophy of Sir William Thomson and his admirers. He says that "the hypothesis that life originated on this earth through moss-grown fragments of another world may seem *wild and visionary;* all I maintain is that it is *not unscientific.*"

I have italicized the phrases which, put together, express the philosophy of this school of modern manufacturers of mathematical hypotheses. It matters not to them how "wild and visionary," how utterly gratuitous any assumption may be, it is not unscientific provided it can be invested in formulæ, and worked out mathematically. These transcendental mathematicians are struggling to carry philosophy back to the era of Duns Scotus, when the greatest triumph of learning was to sophisticate so profoundly an obvious absurdity that no ordinary intellect could refute it.

Fortunately for the progress of humanity, there are other learned men who firmly maintain that the business of science is the discovery and teaching of simple sober truth.

The writer of the *Daily News* article above referred to very charitably suggests that Sir W. Thomson may be "poking fun at some of his colleagues," and compares the moss-grown meteorite hypothesis with the Hindoo parable which explains the stability of the earth by stating that it stands on the back of a monster tortoise, that the tortoise rests upon the back of a gigantic elephant, which stands upon the shell of a still bigger tortoise, resting on the back of another still more gigantic elephant, and so on. Sir W. Thomson, of course, requires to smash two more worlds in order to provide a moss-grown fragment for starting the life upon the world which was broken up for our benefit, and so on backwards *ad infinitum.*

WORLD-SMASHING.

Sir W. Thomson's moss-grown fragment of a shattered world is not yet forgotten. In the current number of the *Cornhill Magazine* (January, 1872) it is very severely handled; the more severely, because the writer, though treating the subject quite popularly, shows the fallacy of the hypothesis, even when regarded from the point of view of Sir W. Thomson's own special department of study. That an eminent mathematician should make a great slip when he ventures upon geological or physiological ground is not at all surprising; it is, in fact, quite to be expected, as there can be no doubt that the close study of *pure* mathematics, by directing the mind to processes of calculation rather than to phenomena, induces that sublime indifference to facts which has characterized the purely mathematical intellect of all ages.

It is not surprising that a philosopher who has been engaged in measuring the imaginary diameter, describing the imaginary oscillations and gyrations of imaginary atoms, and the still more complex imaginary behavior of the imaginary constituents of the imaginary atmospheres by which the mathematical imagination has surrounded these imaginary atoms, should overlook the vulgar fact that neither mosses nor other vegetables, nor even their seeds, can possibly retain their vitality when alternately exposed to the temperature of a blast furnace, and that of two or three hundred degrees below the freezing point; but it is rather surprising that the purely mathematical basis of this very original hypothesis of so great a mathematician should be mathematically fallacious—in plain language, a mathematical blunder.

In order to supply the seed-bearing meteoric fragment by which each planet is to be stocked with life, it is necessary, according to Sir W. Thomson, that two worlds—one at least flourishing with life—shall be smashed; and, in order to get them smashed with a sufficient amount of frequency to supply the materials for his hypothesis, the learned President of the British Association has, in accordance with the customary ingenuity of mathematical theorists, worked out the necessary mathematical conditions, and states with unhesitating mathematical assurance that —"It is as sure that collisions must occur between great masses moving through space, as it is that ships, steered without intelligence directed to prevent collision, could not cross and recross the Atlantic for thousands of years with immunity from collision."

The author of the paper in the *Cornhill* denies this very positively, and without going into the mathematical details, points out the basis upon which it may be mathematically refuted—viz., that all such worlds are traveling in fixed or regular orbits around their primaries or suns, while each of these primaries travels in its own necessary path, carrying with it all its attendants, which still move about him, just as though he had no motion of his own.

These are the conclusions of Newtonian dynamics, the sublime simplicity of which contrasts so curiously with the complex dreams of the modern atom-splitters, and which make a further and still more striking contrast by their exact and perfect accordance with actual and visible phenomena.

Newton has taught us that there can be no planets traveling at random like the Sir W. Thomson's imaginary ships with blind pilots, and by following up his reasoning, we reach the conclusion, that among all the countless millions of worlds that people the infinity of space, there is no more risk of collision than there is between any two of the bodies that constitute our own solar system.

All the observations of astronomers, both before and since the discovery of the telescope, confirm this conclusion. The long nightly watching of the Chaldean shepherds, the star-counting, star-gauging, star-mapping, and other laborious gazing of mediæval and modern astronomers, have failed to discover any collision, or any motion tending to collision, among the myriads of heavenly bodies whose positions and movements have been so faithfully and diligently studied. Thus, the hypothesis of creation which demands the destruction of two worlds in order to effect the sowing of a seed, is as inconsistent with sound dynamics as it is repugnant to common sense.

This subject suggests a similar one, which was discussed a few months since at the Acadamy of Sciences of Paris. On January 30th last M. St. Meunier read a paper on "The mode of rupture of a star, from which meteors are derived." The author starts with the assumption that meteors have been produced by the rupture of a world, basing this assumption upon the arguments he has stated in previous papers. He discards altogether Sir W. Thomson's idea of a collision between two worlds, but works out a conclusion quite as melancholy.

He begins, like most other builders of cosmical theories, with the hypothesis that this and all the other worlds of space began their existence in a condition of nebulous infancy; that they gradually condensed into molten liquids, and then cooled down till they obtained a thin outside crust of solid matter, resting upon a molten globe within; that this crust then gradually thickened as the world grew older and cooled down by radiation. I will not stop to discuss this nebular and cooling-down hypothesis at present, though it is but fair to state that "I don't believe a bit of it."

Taking all this for granted—a considerable assumption—M. St. Meunier reasons very ably upon what must follow, if we further assume that each world is somehow supplied with air and water, and that the atmosphere and the ocean of each world are limited and unconnected with those of any other world, or with any general interstellar medium.

What, then, will happen as worlds grow old? As they cool down, they must contract; the liquid inside can manage this without any inconvenience to itself, but not so with the outer spherical shell of solid matter. As the inner, or hotter part of this contracts, the cool outside must crumple up in order to follow it, and thus mountain chains and great valleys, lesser hills and dales, besides faults and slips, dykes, earthquakes, volcanoes, etc., are explained.

According to M. St. Meunier, the moon has reached a more advanced period of cosmical existence than the earth. She is our senior; and like the old man who shows his gray hairs and tottering limbs to inconsiderate youth, she shines a warning upon our gay young world, telling her that—

> Let her paint an inch thick, to this favor she must come

—that the air and ocean must pass away, that all the living creatures of the earth must perish, and the desolation shall come about in this wise.

At present, the interior of our planet is described as a molten fluid, with a solid crust outside. As the world cools down with age, this crust will thicken and crack, and crack again, as the lower part contracts. This will form *rainures, i.e.*, long narrow chasms, of vast depth, which, like those on the moon, will traverse, without deviation, the mountains, valleys, plains, and ocean-beds; the waters will fall into these, and, after violent catastrophes, arising from their boiling by contact with the hot interior, they will finally disappear from the surface, and become absorbed in the pores of the vastly-thickened earth-crust, and in the caverns, cracks, and chasms which the rending contraction will open in the interior. These cavities will continue to increase, will become of huge magnitude when the outside crust grows thick enough to form its own supporting arch, for then the fused interior will recede, and form mighty vaults that will engulf not the waters merely, but all the atmosphere likewise.

At this stage the earth, according to M. St. Meunier, will be a middle-aged world like the moon; but as old age advances the contraction of the fluid, or viscous interior beneath the outside solid crust will continue, and the *rainures* will extend in length and depth and width, as he maintains they are now growing in the moon. This, he says, must continue till the centre solidifies, and then these cracks will reach that centre, and the world will be split through in fragments corresponding to the different *rainures*.

Thus we shall have a planet composed of several solid fragments held together only by their mutual attractions, but the rotary movement of these will, according to the French philosopher, become unequal, as "the fragments present different densities, and are situated at unequal distances from the centre; some will be accelerated, others retarded; they will rub against each other, and grind away those portions which have the weakest cohesion." The fragments thus worn off will, "at the end of sufficient time, girdle with a complete ring the central star." At this stage the fragments become real meteors, and then perform all the meteoric functions excepting the seed-carrying of Sir W. Thomson.

It would be an easy task to demolish these speculations, though not within the space of one of my letters. A glance at the date of this paper, and the state of Paris and the French mind at the time, may, to some extent, explain the melancholy relish with which the Parisian philosopher works out his doleful speculations. Had the French army marched vigorously to Berlin, I doubt whether this paper would ever have found its way into the "Comptes Rendus." After the fall of Paris, and the wholesale capitulation of the French armies, it was but natural that a patriotic Frenchman, howsoever strong his philosophy, should speculate on the collapse of all the stars, and the general winding-up of the universe.

THE DYING TREES IN KENSINGTON GARDENS.

A GREAT many trees have lately been cut down in Kensington Gardens, and the subject was brought before the House of Commons at the latter part of its last session. In reply to Mr. Ritchie's question, Mr. Adam, the then First Commissioner of Works, made explanations which, so far as they go, are satisfactory—but the distance is very small. He states that all who have watched the trees must have seen that their decay "has become rapid and decided in the last two years," that when the vote for the parks came on many "were either dead or hopelessly dying," that in the more thickly planted portions of the gardens the trees were dead and dying by hundreds, owing to the impoverished soil and the terrible neglect of timely thinning fifty or sixty years ago.

Knowing the sensitiveness of the public regarding tree-cutting, Mr. Adam obtained the co-operation of a committee of experts, consisting of Sir Joseph Hooker, Mr. Clutton, and Mr. Thomas, "so distinguished as a landscape gardener," and the late First Commissioner of Works. They had several meetings, and, as Mr. Adam informs us, "the result has been a unanimous resolution that we ought to proceed at once to clear away the dead and dying trees." This is being done to the extent of "an absolute clearance" in some places, and the removal of numerous trees all over the gardens. We are further told that "the spaces cleared will either be trenched, drained, and replanted, or will be left open, as may appear best." Mr. Adam adds that "the utmost care is being used in the work; that not a tree is being cut that can properly be spared; and that every effort will be made to restore life to the distinguished trees that are dying."

I have watched the proceedings in Kensington Gardens and also in Bushey Park, and have considerable difficulty in describing the agricultural vandalism there witnessed, and expressing my opinion on it, without transgressing the bounds of conventional courtesy towards those who are responsible. I do not refer to the cutting down of the dead and dying trees, but to the proceedings by which they have been officially and artificially killed by those who ought to possess sufficient knowledge of agricultural chemistry to understand the necessary consequences of their conduct.

About forty years have elapsed since Liebig taught to all who were able and willing to learn that trees and other vegetables are composed of two classes of material: 1st, the carbon and elements of water derived from air and rain; and 2d, the nitrogenous and incombustible saline compounds derived from the soil. The possible atmospheric origin of some of the nitrogen is still under debate, but there is no doubt that all which remains behind as incombustible ash, when we burn a leaf, is so much matter taken out of the soil. Every scientific agriculturist knows that certain crops take away certain constituents from the soil, and that if this particular cropping continues without a replacing of those particular constituents of fertility, the soil must become barren in reference to the crop in question, though other crops demanding different food may still grow upon it.

The agricultural vandalism that I have watched with so much vexation is the practice of annually raking and sweeping together the fallen leaves, collecting them in barrows and carts, and then carrying them quite away from the soil in which the trees are growing, or should grow. I have inquired of the men thus employed whether they put anything on the ground to replace these leaves, and they have not merely replied in the negative, but have been evidently surprised at such a question being asked. What is finally done with the leaves I do not know; they may be used for the flower-beds or sold to outside florists. I have seen a large heap accumulated near to the Round Pond.

Now, the leaves of forest trees are just those portions containing the largest proportion of ash; or, otherwise stated, they do the most in exhausting the soil. In Epping Forest, in the New Forest, and other forests where there has been still more "terrible neglect of timely thinning," the trees continue to grow vigorously, and have thus grown for centuries; the leaves fall on the soil wherein the trees grow, and thus continually return to it all they have taken away.

They do something besides this. During the winter they gradually decay. This decay is a process of slow combustion, giving out just as much heat as though all the leaves were gathered together and used as fuel for a bonfire; but the heat in the course of natural decay is gradually given out just when and where it is wanted, and the coating of leaves, moreover, forms a protecting winter jacket to the soil.

I am aware that the plea for this sweeping-up of leaves is the demand for tidiness; that people with thin shoes might wet their feet if they walked through a stratum of fallen leaves. The reply to this is that all reasonable demands of this class would be satisfied by clearing the foot-paths, from which nobody should deviate *in the winter time.* Before the season for strolling in the grass returns, Nature will have disposed of the fallen leaves. A partial remedy may be applied by burning the leaves, then carefully distributing their ashes; but this is after all a clumsy imitation of the natural slow combustion above described, and is wasteful of the ammoniacal salts as well as of the heat. The avenues of Bushey Park are not going so rapidly as the old sylvan glories of Kensington Gardens, though the same robbery of the soil is practiced in both places. I have a theory of my own in explanation of the difference, viz., that the cloud of dust that may be seen blowing from the roadway as the vehicles drive along the Chestnut Avenue of Bushey Park, settles down on one side or the other, and supplies material which to some extent, but not sufficiently, compensates for the leaf-robbery.

The First Commissioner speaks of efforts being made to restore life to the distinguished trees that are dying. Let us hope that these include a restoration to the soil of those particular salts that have for some years past been annually carted away from it in the form of dead leaves, and that this is being done not only around the "distinguished" trees, but throughout the gardens.

Any competent analytical chemist may supply Mr. Adam with a statement of what are these particular salts. This information is obtainable by simply burning an average sample of the leaves and analyzing their ashes.

While on this subject I may add a few words on another that is closely connected with it. In some parts of the parks gardeners may be seen more or less energetically occupied in pushing and pulling mowing-machines; and carrying away the grass which is thus cut. This produces the justly admired result of a beautiful velvet lawn; but unless the continuous exhaustion of the soil is compensated, a few years of such cropping will starve it. This subject is now so well understood by all educated gardeners that it should be impossible to suppose it to be overlooked in our parks, as it is so frequently in domestic gardening. Many a lawn that a few years ago was the pride of its owner is now becoming as bald as the head of the faithful, "practical," and obstinate old gardener who so heartily despises the "fads" of scientific theorists.

When natural mowing-machines are used, *i.e.*, cattle and sheep, their droppings restore all that they take away from the soil, minus the salts contained in their own flesh, or the milk that may be removed. An interesting problem has been for some time past under the consideration of the more scientific of the Swiss agriculturists. From the mountain pasturages only milk is taken away, but this milk contains a certain quantity of phosphates, the restoration of which must be effected sooner or later, or the produce will be cut off, especially now that so much condensed milk is exported.

The wondrously rich soil of some parts of Virginia has been exhausted by unrequited tobacco crops. The quantity of ash displayed on the burnt end of a cigar demonstrates the exhausting character of tobacco crops. That which the air and water supplied to the plant is returned as invisible gases during combustion, but all the ash that remains represents what the leaves have taken from the soil, and what should be restored in order to sustain its pristine fertility.

The West India Islands have similarly suffered to a very serious extent on account of the former ignorance of the the sugar planters, who used the canes as fuel in boiling down the syrup, and allowed the ashes of those canes to be washed into the sea. They were ignorant of the fact that pure sugar may be taken away in unlimited quantities without any impoverishment of the land, seeing that it is composed merely of carbon and the elements of water, all derivable from air and ruin. All that is needed to maintain the perennial fertility of a sugar plantation is to restore the stems and leaves of the cane, or carefully to distribute their ashes.

The relation of these to the soil of the sugar plantations is precisely the same as that of the leaves of the trees to the soil of Kensington Gardens, and the reckless removal of either must produce the same disastrous consequences.

THE OLEAGINOUS PRODUCTS OF THAMES MUD: WHERE THEY COME FROM AND WHERE THEY GO.

ONCE upon a time—and not a very long time since—a French chemist left the land of superexcellence, and crossed to the shores of foggy Albion. He proceeded to Yorkshire, his object being to make his fortune. He was so presumptuous as to believe that he might do this by picking up something which Yorkshiremen threw away. That something was soapsuds. His chemistry taught him that soap is a compound of fat and alkali, and that if a stronger acid than that belonging to the fat is added to soapsuds, the stronger acid will combine with the alkali and release the fat, the which fat thus liberated will float upon the surface of the liquid, and may then be easily skimmed off, melted together, and sold at a handsome profit.

But why leave the beautiful France and desolate himself in dreary Yorkshire merely to do this? His reason was, that the clothworkers of Yorkshire use tons and tons of soap for scouring their materials, and throw away millions of gallons of soapsuds. Besides this, there are manufactories of sulphuric acid near at hand, and a large demand for machinery grease just thereabouts. He accordingly bought iron tanks, and erected works in the midst of the busiest centre of the woolen manufacture. But he did not make his fortune all at once. On the contrary, he failed to pay expenses, for in his calculations he had omitted to allow for the fact that the soap liquor is much diluted, and therefore he must carry much water in order to obtain a little fat. This cost of carriage ruined his enterprise, and his works were offered for sale.

The purchaser was a shrewd Yorkshireman, who then was a dealer in second-hand boilers, tanks, and other iron wares. When he was about to demolish the works, the Frenchman took him into confidence, and told the story of his failure. The Yorkshireman said little, but thought much; and having finally assured himself that the carriage was the only difficulty, he concluded, after the manner of Mahomet, that if the mountain would not come to him, he might go to the mountain; and then made an offer of partnership on the basis that the Frenchman should do the chemistry of the work, and that he (the Yorkshireman) should do the rest.

Accordingly, he went to the works around, and offered to contract for the purchase of all their soapsuds, if they would allow him to put up a tank or two on their premises. This he did; the acid was added, the fat rose to the surface, was skimmed off, and carried, *without the water*, to the central works, where it was melted down, and, with very little preparation, was converted into "cold-neck grease," and "hot-neck grease," and used, besides, for other lubricating purposes. The Frenchman's science and skill, united with the Yorkshireman's practical sagacity. built up a flourishing business, and the grease thus made is still in great demand and high repute for lubricating the rolling-mills of iron works, and for many other kinds of machinery.

My readers need not be told that there are soapsuds in London as well as in Yorkshire, and they also know that the London soapsuds pass down the drains into the sewers. I may tell them that besides this there are many kinds of acids also passed into London sewers, and that others are generated by the decompositions there abounding. These acids do the Frenchman's work upon the London soapsuds, but the separated fat, instead of rising slowly and undisturbed to form a film upon the surface of the water, is rolled and tumbled amongst its multifarious companion filth, and it sticks to whatever it may find congenial to itself. Hairs, rags, wool, ravellings of cotton, and fibres of all kinds are especially fraternal to such films of fat: they lick it up and stick it about and amid themselves; and as they and the fat roll and tumble along the sewers together, they become compounded and shaped into unsavory balls that are finally deposited on the banks of the Thames, and quietly repose in its hospitable mud.

But there is no peace even there, and the gentle rest of the fat nodules is of short duration. The mud-larks are down upon them, in spite of all their burrowing; they are gathered up and melted down. The filthiest of their associated filth is thus removed, and then, and with a very little further preparation, they appear as cakes of dark-colored hard fat, very well suited for lubricating machinery, and indifferently fit for again becoming soap, and once more repeating their former adventures.

Those gentlemen of the British press whose brilliant imagination supplies the public with their intersessional harvests of sensational adulteration panics, have obtained a fertile source of paragraphs by co-operating with the mudlarks in the manufacture of butter from Thames mud.

The origin of these stories is traceable to certain officers of the Thames police, who, having on board some of these gentlemen of the press engaged in hunting up information respecting a body found in the river, supplied their guests with a little supplementary chaff by showing them a mudlark's gatherings, and telling them that it was raw material from which "fine Dorset" is produced. A communication from "Our Special Correspondent" on the manufacture of butter from Thames mud accordingly appeared in the atrocity column on the following morning, and presently "went the round of the papers."

Although it is perfectly possible by the aid of modern chemical skill to refine even such filth as this, and to churn it into a close resemblance to butter, the cost of doing so would exceed the highest price obtainable for the finest butter that comes to the London market. A skillful chemist can convert all the cotton fibres that are associated with this sewage fat into pure sugar or sugar-candy, but the manufacture of sweetmeats from Thames mud would not pay any better than the production of butter from the same source, and for the same reason.

Mutton-suet, chop-parings, and other clean, wholesome fat can be bought wholesale for less than fivepence per pound. It would cost above three times as much as this to bring the fat nodules of the Thames mud to as near an approach to butter as this sort of fat. Therefore the Thames mud-butter material would be three times as costly as that obtainable from the butcher. While the supply of mutton-suet is so far in excess of the butter-making demand that tons of it are annually used in the North for lubricating machinery, we need not fear that anything less objectionable —*i.e.*, more costly to purify—will be used as a butter substitute.

LUMINOUS PAINT.

THE sun is evidently going out of fashion, and is more and more excluded from "good society" as our modern substitute for civilization advances. "Serve him right!" many will say, for behaving so badly during the last two summers. The old saw, which says something about "early to bed and early to rise" is forgotten: we take "luncheon" at dinner-time, dine at supper-time, make "morning" calls and go to "morning" concerts, etc., late in the afternoon, say "Good morning" until 6 or 7 P. M.; and thus, by sleeping through the bright hours of the morning, and waking up fully only a little before sunset, the demand for artificial light becomes almost overwhelming. Not only do we require this during a longer period each day, but we insist upon more and more, and still more yet, during that period.

The rushlight of our forefathers was superseded by an exotic luxury, the big-flame candle made of Russian tallow, with a wick of Transatlantic cotton. Presently this luxurious innovation was superseded by the "mould candle;" the dip was consigned to the kitchen, and the bloated aristocrats of the period indulged in a *pair* of candlesticks, alarming their grandmothers by the extravagance of burning two candles on one table. Presently the mould candle was snuffed out by the composite; then came the translucent pearly paraffin candle, gas light, solar lamps, moderator lamps, and paraffin lamps. Even these, with their brilliant white flame from a single wick, are now insufficient, and we have duplex and even triplex wicks to satisfy our demand for glaring mockeries of the departed sun.

Some are still living who remember the oil lamps in

Cheapside and Piccadilly, and the excitement caused by the brilliancy of the new gas lamps; but now we are dissatisfied with these, and demand electric lights for common thoroughfares, or some extravagant combination of concentric or multiplex gas-jets to rival it.

The latest novelty is a device to render darkness visible by capturing the sunbeams during the day, holding them as prisoners until after sunset, and then setting them free in the night. The principle is not a new discovery; the novelty lies in the application and some improvements of detail. In the "Boy's Own Book," or "Endless Amusement," of thirty or forty years ago, are descriptions of "Canton's phosphorus," or "solar phosphori," and recipes for making them. Burnt oyster-shells or oyster-shells burnt with sulphur, was one of these.

Various other methods of effecting combination between lime or baryta with sulphur are described in old books, the result being the formation of more or less of what modern chemists call calcium sulphide and barium sulphide (or otherwise sulphide of calcium or sulphide of barium). These compounds, when exposed to the sun, are mysteriously acted upon by the solar rays, and put into such a condition that their atoms or molecules, or whatever else constitutes their substance, are set in motion—in that sort of motion which communicates to the surrounding medium the wavy tremor which agitates our optic nerve and produces the sensation of light.

Until lately, this property has served no other purpose than puzzling philosophers, and amusing that class of boys who burn their fingers, spoil their clothes, and make holes in their mothers' table-covers, with sulphuric acid, nitric acid, and other noxious chemicals. The first idea of turning it to practical account was that of making a sort of enamel of one or the other of these sulphides, and using it as a coating for clock-faces. A surface thus coated and exposed to the light during the day becomes faintly luminous at night.

Anybody desirous of seeing the sort of light which it emits, may do so very easily by purchasing an unwashed smelt from the fishmonger, and allowing it to dry with its natural slime upon it, then looking at it in the dark. A sole or almost any other fish will answer the purpose, but I name the smelt from having found it the most reliable in the course of my own experiments. It emits a dull, ghostly light, with very little penetrating power, which shows the shape of the fish, but casts no perceptible light on objects around.

Thus the phosphorescent parish-clock face, with non-phosphorescent figures and hands, would look like a pale ghost of the moon with dark figures round it, and dark hands stretching across, by which the time of the night might possibly be discovered there or thereabouts. This invention has already appeared in a great many paragraphs, but, hitherto, upon very few clock-faces.

Recently it has assumed a more ambitious form—patented, of course. The patentees claim an improved phosphorescent powder, which is capable of being worked up with the medium of paints and varnishes, and thus applied, not merely to clock-faces, but to the whole of the walls and ceilings of any apartment. In this case the faintness of the light will be in some degree compensated by the extent of phosphorescent surface, and it is just possible that the sum total of the light emitted from walls and ceiling may be nearly equal to that of one mould candle. If so, it will have some value as a means of lighting powder magazines and places for storage of inflammable compounds. It is stated that one of the London Dock companies is about to use it for its spirit vaults; also that the Admiralty has already tried the paint at Whitehall, and has ordered two compartments of the *Comus* to be painted with it, in order to test its capability of lighting the dark regions of ironclad ships.

This application can, however, only be limited to those parts which receive a fair amount of light during the day, for unless the composition first receives light, it is not able afterwards to emit it, and this emission or phosphorescence only continues a few hours after the daylight has passed away; five or six hours is the time stated.

A theatrical manager is said to be negotiating for the exclusive right to employ this weird illumination for scenic purposes. The sepulchre scene in "Robert le Diable," or the incantation in "Der Freischutz," or "The Sorcerer," might be made especially effective by its ghostly aid. The name-plates of streets, and buoys at sea might be advantageously coated with such a composition; and many other uses suggest themselves.

There are rival inventors, as a matter of course. The French patentees claim the use of cuttle-fish bones, various sea-shells, etc., mixed with pure lime, sulphur, and calcined sea-salt, besides sulphides of calcium, barium, strontium, uranium, magnesium, or aluminium. They also add phosphorus itself, though for what purpose is questionable, seeing that this substance is only luminous during the course of its oxidation or slow combustion, and after this has ended the resultant phosphoric acid is no more luminous than linseed oil or turpentine. An admixture of phosphorus might temporarily increase the luminosity of a *sample*, but any conclusions based upon this would be quite delusive. They also assert that electrical discharges passed through the paint increase its luminosity. According to some enthusiasts, electricity is to do everything; but these ladies and gentlemen omit to calculate the cost of rousing and feeding this omnipotent giant. In this case electrical machinery for stimulating the paint for anything outside of lecture-table experiments or theatrical and other sensational displays, would be a commercial absurdity.

The Americans, of course, are re-inventing in this direction, but Mr. Edison has not yet appeared on the luminous-paint scene. If he does we shall doubtless hear of something very brilliant, even though we never see it. In the meantime we may safely hope that this application of an old scientific plaything to useful purposes may become of considerable utility, as it evidently opens a wide field for further investigation and progressive improvement, by the application of the enlarged powers which modern science places at the disposal of ingenious inventors. We hope, for the sake of all concerned, that it will not fall into the hands of professional prospectus manufacturers and joint-stock-company mongers, and that the story of its triumphs will be told without any newspaper exaggerations.

Since the above was written—in February, 1880—I have tested this luminous paint (Balmain's patent). Practically, I find it unsatisfactory. In the first place, its endurance is far shorter than is stated. It begins to fade almost immediately the light is withdrawn, and in the course of an hour or two it is, for all practical use—though not absolutely—extinguished. Besides this it emits a very unpleasant odor painfully resembling sewage and sulphureted hydrogen. This is doubtless due to the sulphur compound, but is, I have no doubt, quite harmless in spite of its suggestions.

THE ORIGIN AND PROBABLE DURATION OF PETROLEUM.

In spite of the enormous quantities of mineral oil that are continuously drawn from the earth, and the many places from which it may thus be drawn, geologists are still puzzled to account for it. If it were commonly associated with coal the problem of its origin would be solved at once. We should then be satisfied that natural mineral oil is produced in the same manner as the artificial product, *i.e.*, by the heating and consequent distillation of certain kinds of coal or of bituminous shales; but, as a matter of fact, it is but rarely that petroleum is found in the midst of coal seams, though it is sometimes so found.

I visited, some years ago, a coal-mine in Shropshire, known as "the tarry pit," thus named on account of the large quantity of crude mineral oil of a rather coarse quality that exuded from the strata pierced by the shaft. It ran down the sides of the shaft, filled the "sumph" (*i.e.*, the well at the bottom of the shaft in which the water draining from the mine should accumulate for pumping), and annoyed the colliers so seriously that they refused to work in the mine unless the nuisance were abolished. It was abolished by "tubbing" the shaft with an oil-proof lining built round that part from which the oil issued. The "tar" as the crude oil was called, was then pumped out of the sumph, and formed a pool which has since been filled up by the *débris* of the ordinary mine workings.

A publican in the Black Country of South Staffordshire discovered an issue of inflammable vapor in his cellar, collected it by thrusting a pipe into the ground, and used it for lighting and warming purposes, as well as an attraction to customers.

These and other cases that might be cited, although exceptional, are of some value in helping us to form a simple and rational theory of the origin of this important natural product. They prove that mineral oil *may* be produced in connection with coal seams and apparently from the coal itself. A sound theory of the origin of petroleum is of practical as well as theoretical value, inasmuch as the very practical question of the probable permanency of supply depends entirely on the nature of the origin of that supply. Some very odd theories have been put forth, especially in America.

Seeing that petroleum is commonly found associated with sandstone and limestone, especially in cavities of the latter, it has been supposed that these minerals somehow produce it. Turning back to the *Grocer* for April 18, 1879, I find some speculations of this kind quoted from the *Petroleum Monthly* The writer sets aside altogether, as an antiquated and exploded fallacy, the idea that petroleum is produced from coal, and maintains "that petroleum is mainly produced from, or generated through, limestone," and argues that the generation of petroleum by such rocks is a continuous process, from the fact that exhausted wells have recovered after being abandoned, his explanation being "that the formerly abandoned territory was given up because the machinery for extracting petroleum from the earth exceeded in its power of exhausting the fluid the generative powers by which it is produced;" these generative powers somehow residing in the limestone and sandstone, but how is not specified.

Some writers have, however, gone a little further toward answering the question of how limestone may generate petroleum. They have pointed to the fossilized remains of animals, their shells, etc., existing in the limestone, and have supposed that the animal matter has been distilled, and has thus formed the oil.

If such a process could be imitated artificially by distilling some of the later deposits of similar fossil character this theory would have a better basis, or even if a collection of oysters, mussels, or any other animal matters could by distillation be shown to produce an oil similar to petroleum.

The contrary is the case. We may obtain oil from such material, but it is utterly different from any kind of mineral oil, while, on the other hand, by distilling natural bituminous shales, or cannel coal, or peat, we obtain a crude oil almost identical with natural petroleum, and the little difference between the two is perfectly accounted for by the greater rapidity of our methods of distillation as compared with the slow natural process. We may go on approximating more and more nearly to the natural petroleum by distilling more and more slowly. As it is, the refined products of the natural and artificial oil which is commercially distilled in Scotland, are scarcely distinguishable—some of them are not at all distinguishable—the solid paraffin, for example. I now offer my own theory of the origin of oil springs.

To render this the more intelligible, let us first consider the origin of ordinary water springs. St. Winifred's Well, at Holywell, in Flintshire, may be taken as an example, not merely on account of its magnitude, but because it is quite typical, and is connected with limestone and sandstone in about the same manner as are the petroleum wells of Pennsylvania.

Here we have a wondrous uprush of water just between the sandstone and mountain limestone rocks, which amounts to above twenty tons per minute, and flows down to the Dee, a small river turning several water-mills. It is certain that all this water is not generated either by the limestone or the sandstone from which it issues, nor can it be all "generated" on the spot. The true explanation of its origin is simple enough.

The mountain limestone underlies the coal measures and crops up obliquely at Holywell; against this oblique subterranean wall of compact rock impermeable to water, abuts a great face of down-sloping strata of porous sandstone and porous shales. These porous rocks receive the rain which falls on the slopes of the Hope Mountain and other hills which they form; this water sinks into the millstone grit of these hills and percolates downwards until it reaches the limestone barrier, into which it cannot penetrate.

It here accumulates as a subterranean reservoir which finds an outlet at a convenient natural fissure, and, as the percolation is continuous, the spring is a constant one. Some of the water travels many miles underground before it thus escapes. Hundreds of other smaller instances might be quoted, the above being the common history of springs which start up whenever the underground waters that flow through porous rocks or soil meet with compact rocks or impermeable clay, and thus, being able to proceed no further downwards, accumulate and produce an overflow which we call a "spring."

If water can thus travel underground, why not oil?

Although the oil springs or oil wells are not immediately above or below coal seams, they are all within "measurable distance" of great coal formations—the oil territory of Pennsylvania is, in fact, surrounded by coal, some of it anthracite, which is really a coke, such as would be produced if we artificially distilled the hydrocarbons from coal, and then compressed the residue, as the anthracite has certainly been pressed by the strata resting upon it.

The rocks in immediate contact and proximity to coal seams—"the coal measures," as they are called—are mostly porous, some of them very porous, and thus if at any period of the earth's long history a seam of coal became heated, as we know so many strata are, and have been heated, a mineral oil would certainly be formed, would first permeate the porous rocks as vapor, then be condensed and make its way through them, following their "dip" or inclination until it reached a barrier such as the limestone forms.

It would thus in after-ages be found, not among the coal where it was formed, but at the limestone or other impermeable rock by which its further percolation was arrested.

This is just where it actually is found.

Limestone, although not porous like shales and sandstones, is specially well adapted for storing large subterranean accumulations, on account of the grent cavities to which it is liable. Nearly all the caverns in this country, in Ireland where they abound, in America, and other parts of the world, are in limestone rocks; they are especially abundant in the "carboniferous limestone" which underlies the coal measures, and this is explained by the fact that limestone may be dissolved by rain-water that has oozed through vegetable soil or has soaked fallen leaves or other vegetable matter, and thereby become saturated with carbonic acid.

Where the petroleum finds a crevice leading to such cavities it must creep through it and fill the space, thereby forming one of the underground reservoirs supplying those pumping wells that have yielded such abundance for a while and then become dry. But if this theory is correct it does not follow that the drying of such a well proves a final stoppage of the supply, for if the cavity and crevice are left, more oil may ooze into the crevice and flow into the cavity, and this may continue again and again throughout the whole oil district so long as the surrounding feeders of permeable strata continue saturated, or nearly so. The magnitude of these feeding grounds may far exceed that of the district wherein the springs occur, or where profitable wells may be sunk, seeing that the localizing of profitable supply depends mainly on the stoppage of further oozing away by the action of the impermeable barrier.

A well sunk into the oozing strata itself would receive a very small quantity, only that which, in the course of its passage came upon the well sides, while at the junction between the permeable and the impermeable rocks the accumulation may include all that reached the whole surface of such junction or contact—many square miles.

To test this theory thoroughly it would be necessary to make borings, not merely at the wells, but in their neighborhood, where the porous rocks dip towards the limestone, and to bring up sample cores of these porous rocks, and carefully examine them. Dr. Sterry Hunt has done this in the oil-yielding limestone rocks of Chicago, but not in those of the nearest coal-measures.

As the oil industry of America is of such great national importance, an investigation of this kind is worthy of the energies of the American Government geologists. It would throw much light on the whole subject, and supply data from which the probable duration of the oil supply might be approximately calculated.

Such an investigation might even do more than this. By proving the geological conditions upon which depend the production of petroleum springs, new sources may be discovered, just as new coal-seams have been discovered, in accordance with geological prediction, or as the practical discovery of the Austrian gold-fields was so long preceded by Sir Roderick Murchison's theoretical announcement of their probable existence.

When the "kerosene wells" were first struck, the speculations concerning their probable permanency were wild and various. Some maintained that it was but a spurt, a freak of nature limited to a narrow locality, and would soon be over; others asserted forthwith that American oil, like everything else American, was boundless. Neither had any grounds for their assertions, and therefore made them with the usual boldness of mere dogmatism.

Then came a period of scare, started by the fact that wells which at first spouted an inflammable mixture of oil and vapor high into the air soon became quiescent, and from "spouting wells" became "flowing wells," merely pouring out on the surface a small stream at first, which gradually declined to a dribble, and finally ceased to flow at all. Even those that started modestly as flowing wells did the latter, and thus appeared to become exhausted.

This exhaustion, however, was only apparent, as was proved by the application of pumps, which drew up from wells, that had ceased either to spout or flow, large and apparently undiminishing quantities of crude oil.

Further observation and thought revealed the cause of these changes. It became understood that the spouting was due to the tapping of a rock-cavity containing oil of such varying densities and volatility that some of it flew out as a vapor, or boiled at the mean temperature of the air of the country or that of the surrounding rocks. Such being the case, the cavity was filled with high-pressure oil-vapor straining to escape. If the bore-hole tapped the crown or highest curve of the roof of such an oil-cavern, it opened directly into the vapor there accumulated, and the vapor itself rushed out with such force that a pillar of fire was raised in the air if a light came within some yards of the orifice. We are told of heavy iron boring-rods that were shot up to wondrous heights—and we may believe these stories if we please.

If the bore-hole struck lower down, somewhere on the sloping sides or in the shallow lower branches of the oil-cavern, it dipped at once into liquid oil, and this oil, being pressed by the elastic vapor of the upper part, was forced up as a-jet of spouting oil.

In either case these violent proceedings soon came to an end, for as the vapor or oil poured out, the space above the oil-level where the vapor had been confined was increased, and its pressure diminished, till at last it barely sufficed to raise the oil to the surface, and afterwards failed to do that.

It is quite clear from this that the supplies are not "inexhaustible." The quantity of vapor having been limited, there must also be a limit to the quantity of oil giving off this vapor; the space in the oil-cavern occupied by this vapor having been limited, there must be a limit to the space occupied by the oil. The quantity of oil may be ten times, a hundred times, a thousand times, or ten thousand times, greater than that of the vapor, but in either or any case it must come to an end at last, sooner later.

If there were but a few wells here and there, as at other similar places, such as Rangoon, the Persian oil-wells, etc., the pumping might continue for centuries and centuries; but this is not the case in America. The final boundaries of the oil-bearing strata may not yet have been reached; but so far as they are known they are riddled through and through, and pumped in every direction, so that the end must come at last, though with our present knowledge we cannot say *when*.

We can, however, say *how* it must come. It will not be a sudden stoppage, but a gradual exhaustion indicated by progressive diminution of supply. We shall not be suddenly deprived of this important source of light and cheerfulness; but we may at any time begin to feel the pinch of scarcity and consequent rise of price. This rise of price will check the demand, and bring forth other supplies from sources that now cannot be profitably worked on account of the cheapness of American petroleum.

Many of the countries now largely supplied from America have oil-springs of their own, which a rise of price will speedily bring into paying operation.

We have nothing to fear. The fact that in spite of the ruinous prices that have recently prevailed the Scotch oil-makers continue to exist at all, shows us what they may do with a rise of even a few pence per gallon. The thickness and area of the dark shales from which their oil is distilled are so great that their exhaustion is very far remote indeed. The Americans have similar shales to fall back upon when the spontaneous product ceases to flow, but they are quite incapable of competing with us at home on equal terms—that is, when both have to obtain the oil as a manufactured product of artificial distillation.

If anything like moderation were possible in America, the first indications of scarcity would be followed by some economy in working; but this is not to be anticipated. It is more likely that the first rise of prices will attract additional speculation, and the sinking of more wells in the hope of large profits, and this of course will shorten the period of gradual exhaustion, the commencement of which may, for aught we know, be very near at hand, especially if the new projects for using petroleum as furnace fuel under steam boilers, and for the smelting, puddling, and founding of iron and other metals, are carried out as they may be so easily at present prices, and with the aid of pipe-lines to carry the crude or refined oil from the wells to any part of the great American continent where it may be required in large quantities.

The old story of the goose that laid the golden eggs seems to be in course of repetition in Transatlantic Petrolia.

Since the above was written I have received from Dr.

Sterry Hunt a copy of his interesting "Chemical and Geological Essays," in one of which he expounds a theory of the origin of petroleum. He states that it appears to him "that the petroleum, or rather the materials from which it has been formed, existed in the limestone rocks from the time of their first deposition," and "that petroleum and similar bitumens have resulted from a peculiar transformation of vegetable matters, or in some cases of animal tissues analogous to these in composition."

The objections on page 275 apply to the animal tissues of this theory, and as regards the vegetable matter I think it fails from the want of anything like an adequate supply in these limestone rocks.

THE ORIGIN OF SOAP.

A HISTORY of soap would be very interesting. Who invented it? When and where did it first come into common use? How did our remote ancestors wash themselves before soap was invented? These are historical questions that naturally arise at first contemplation of the subject; but, as far as we are aware, historians have failed to answer them. We read a great deal in ancient histories about anointing with oil and the use of various cosmetics for the skin, but nothing about soap.

These ancients must have been very greasy people, and I suspect that they washed themselves pretty nearly in the same way as modern engine-drivers clean their fingers, by wiping off the oil with a bit of cotton-waste.

We are taught to believe that the ancient Romans wrapped themselves round with togas of ample dimensions, and that these togas were white. Now, such togas, after encasing such anointed oily skins, must have become very greasy. How did the Roman laundresses or launders—historians do not indicate their sex—remove this grease? Historians are also silent on this subject.

A great many curious things were found buried under the cinders of Vesuvius in Pompeii, and sealed up in the lava that flowed over Herculaneum. Bread, wine, fruits, and other domestic articles, including several luxuries of the toilet, such as pomades or pomade-pots, and rouge for painting ladies' faces, but no soap for washing them. In the British Museum is a large variety of household requirements found in the pyramids of Egypt, but there is no soap, and we have not heard of any having been discovered there.

Finding no traces of soap among the Romans, Greeks, or Egyptians, we need not go back to the pre-historic "cave men," whose flint and bone implements were found embedded side by side with the remains of the mammoth bear and hyena in such caverns as that at Torquay, where Mr. Pengelly has, during the last eighteen years, so industriously explored.

All our knowledge, and that still larger quantity, our ignorance, of the habits of antique savages, indicate that solid soap, such as we commonly use, is a comparatively modern luxury; but it does not follow that they had no substitute. To learn what that substitute may probably have been we may observe the habits of modern savages, or primitive people at home and abroad.

This will teach us that clay, especially where it is found having some of the unctuous properties of fuller's-earth, is freely used for lavatory purposes, and was probably used by the Romans, who were by no means remarkable for anything approaching to true refinement. They were essentially a nasty people, the habits of the poor being "cheap and nasty;" of the rich, luxurious and nasty. The Roman nobleman did not sit down to dinner, but sprawled with his face downwards, and took his food as modern swine take theirs. At grand banquets, after gorging to repletion, he tickled his throat in order to vomit and make room for more. He took baths occasionally, and was probably scoured and shampooed as well as oiled, but it is doubtful whether he performed any intermediate domestic ablutions worth naming.

A refinement upon washing with clay is to be found in the practice once common in England, and still largely used where wood fires prevail. It is the old-fashioned practice of pouring water on the wood ashes, and using the "lees" thus obtained. These lees are a solution of alkaline carbonate of potash the modern name of potash being derived from the fact that it was originally obtained from the ashes under the pot. In like manner soda was obtained from the ashes of seaweeds and of the plants that grow near the seashore, such as the *salsover soda*, etc.

The pot-ashes or pearl-ashes being so universal as a domestic bi-product, it was but natural that they should be commonly used, especially for the washing of greasy clothes, as they are to the present day. Upon these facts we may build up a theory of the origin of soap.

It is a compound of oil or fat with soda or potash, and would be formed accidentally if the fat on the surface of the pot should boil over and fall into the ashes under the pot. The solution of such a mixture if boiled down would give us soft soap.

If oil or fat became mixed with the ashes of soda plants, it would produce hard soap. Such a mixture would most easily be formed accidentally in regions where the olive flourishes near the coast, as in Italy and Spain for example, and this mixture would be Castile soap, which is still largely made by combining refuse or inferior olive oil with the soda obtained from the ashes of seaweed.

The primitive soap-maker would, however, encounter one difficulty—that arising from the fact that the potash or soda obtained by simple burning of the wood or seaweed is more or less combined with carbonic acid, instead of being all in the caustic state which is required for effective soap-making. The modern soap-maker removes this carbonic acid by means of caustic lime, which takes it away from the carbonate of soda or carbonate of potash by simple exchange—*i.e.*, caustic lime *plus* carbonate of soda becoming caustic soda *plus* carbonate of lime, or carbonate of potash *plus* caustic lime becoming caustic potash *plus* carbonate of lime.

How the possibility of making this exchange became known to the primitive soap-maker, or whether he knew it at all, remains a mystery, but certain it is that it was practically used long before the chemistry of the action was at all understood. It is very probable that the old alchemists had a hand in this.

In their search for the philosopher's stone, the elixir of life, or drinkable gold, and for the universal solvent, they mixed together everything that came to hand, they boiled everything that was boilable, distilled everything that was volatile, burnt everything that was combustible, and tortured all their "simples" and their mixtures by every conceivable device, thereby stumbling upon many curious, many wonderful, and many useful results. Some of them were not altogether visionary—were, in fact, very practical, quite capable of understanding the action of caustic lime on carbonate of soda, and of turning it to profitable account.

It is not, however, absolutely necessary to use the lime, as the soda plants when carefully burned in pits dug in the sand of the sea-shore may contain but little carbonic acid if the ash is fluxed into a hard cake like that now commonly produced, and sold as "soda ash." This contains from three to thirty per cent of carbonate, and thus some samples are nearly caustic, without the aid of lime.

As cleanliness is the fundamental basis of all true physical refinement, it has been proposed to estimate the progress of civilization by the consumption of soap, the relative civilization of given communities being numerically measured by the following operation in simple arithmetic:—Divide the total quantity of soap consumed in a given time by the total population consuming it, and the quotient expresses the civilization of that community.*

The allusion made by Lord Beaconsfield, at the Lord Mayor's dinner in 1879, to the prosperity of our chemical manufactures was a subject of merriment to some critics, who are probably ignorant of the fact that soap-making is a chemical manufacture, and that it involves many other chemical manufactures, some of them, in their present state, the results of the highest refinements of modern chemical science.

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* The scientific pedant of the Middle Ages displayed his profundity by continually quoting Aristotle and other "ancients." His modern successor does the like by decorating his pages with displays of algebraical formulæ. In order to secure the proper respect of *my* readers I here repeat the equation that I enunciated many years ago, "$c = \frac{s}{p}$" where c stands for civilization, s for the quantity of soap consumed per annum, and p the population of a given community.

While the fishers of the Hebrides and the peasants on the shores of the Mediterranean are still obtaining soda by burning seaweed as they did of old, our chemical manufacturers are importing sulphur from Sicily and Iceland, pyrites from all quarters, nitrate of soda from Peru and the East Indies, for the manufacture of sulphuric acid, by the aid of which they now make enormous quantities of caustic soda from the material extracted from the salt mines of Cheshire and Droitwich. These sulphuric acid works and these soda works are among the most prosperous and rapidly growing of our manufacturing industries, and their chief function is that of ministering to soap-making, in which Britain is now competing triumphantly with all the world.

By simply considering how much is expended annually for soap in every decent household, and adding to this the quantity consumed in laundries and by our woolen and cotton manufacturers, a large sum total is displayed. Formerly, we imported much of the soap we used at home; now, in spite of our greatly magnified consumption, we supply ourselves with all but a few special kinds, and export very large and continually increasing quantities to all parts of the world; and if the arithmetical rule given above is sound, the demand must steadily increase as civilization advances.

OILING THE WAVES.

The recent gales have shown that if "Britannia rules the waves" her subjects are very turbulent and costly. Our shipping interests are now of enormous magnitude, and they are growing year by year. We are, in fact, becoming the world's carriers on the ocean, and are thus ruling the waves in a far better sense than in the old one. Our present mercantile rule adds to the wealth of our neighbors instead of destroying it, as under the old warlike rule.

Everything concerning these waves is thus of great national interest, the loss of life and sacrifice of wealth by marine casualties being so great. Some curious old stories are extant, describing the exploits of ancient mariners in stilling the waves by pouring oil upon them. Both Plutarch and Pliny speak of it as a regular practice. Much later than this, in a letter dated Batavia, January 5, 1770, written by M. Tengragel, and addressed to Count Bentinck, the following passage occurs:—"Near the islands Paul and Amsterdam we met with a storm, which had nothing particular in it worthy of being communicated to you, except that the captain found himself obliged, for greater safety in wearing the ship, to pour oil into the sea to prevent the waves breaking over her, which had an excellent effect, and succeeded in preserving us. As he poured out but a little at a time, the East India Company owes, perhaps, its ship to only six demi-aumes of olive oil. I was present on deck when this was done, and should not have mentioned this circumstance to you, but that we have found people here so prejudiced against the experiment as to make it necessary for the officers on board and myself to give a certificate of the truth on this head, of which we made no difficulty."

The idea was regarded with similar prejudice by scientific men until Benjamin Franklin had his attention called to it, as he thus narrates:—"In 1757, being at sea in a fleet of ninety-six sail, bound for Louisbourg, I observed the wakes of two of the ships to be remarkably smooth, while all the others were ruffled by the wind, which blew fresh. Being puzzled with the differing appearance, I at last pointed it out to the captain, and asked him the meaning of it. 'The cooks,' said he, 'have, I suppose, been just emptying their greasy water through the scuppers, which has greased the sides of the ships a little.' And this answer he gave me with an air of some little contempt, as to a person ignorant of what everybody else knew. In my own mind, I first slighted the solution, though I was not able to think of another."

Franklin was not a man to remain prejudiced; he accordingly investigated the subject, and the results of his experiments, made upon a pond on Clapham Common, were communicated to the Royal Society. He states that after dropping a little oil on the water, "I saw it spread itself with surprising swiftness upon the surface, but the effect of smoothing the waves was not produced; for I had applied it first upon the leeward side of the pond, where the waves were largest, and the wind drove my oil back upon the shore. I then went to the windward side, where they began to form; and there the oil, though not more than a teaspoonful, produced an instant calm over a space several yards square, which spread amazingly, and extended itself gradually till it reached the lee side, making all that quarter of the pond (perhaps half an acre) as smooth as a looking-glass."

Franklin made further experiments at the entrance of Portsmouth Harbor, opposite the Haslar Hospital, in company with Sir Joseph Banks, Dr. Blagden, and Dr. Solander. In these experiments the waves were not destroyed, but were converted into gentle swelling undulations with smooth surfaces. Thus it appeared that the oil destroys small waves, but not large billows.

Franklin's explanation is, "that the wind blowing over water covered with a film of oil cannot easily *catch* upon it, so as to raise the first wrinkles, but slides over it and leaves it smooth as it finds it."

Further investigations have since been made which confirm this theory. The first action of the wind in blowing up what the sailors call "a sea," is the production of a ripple on the surface of the water. This ripple gives the wind a strong hold, and thus larger waves are formed, but on these larger there are smaller waves, and on these smaller waves still smaller ripples. All this roughness of surface goes on helping the wind, till at last the mightiest billows are formed, which then have an oscillation independent of the wind that formed them. Hence the oil cannot at once subdue the great waves that are already formed, but may prevent their formation if applied in time. Even the great waves are moderated by the oil stopping the action of the wind which sustains and augments them.

Quite recently, Captain David Gray made some experiments at the north bar of Peterhead, where a very heavy surf breaks over in rough weather. On a rough day he dropped a bottle full of oil into the sea. The oil floating out of the bottle, converted the choppy waves over a large area "into an expanse of long undulating rollers, smooth and glassy, and so robbed of all violence that a small open boat could ride on them in safety."

This result is quite in accordance with what we are told respecting the ancient practice of the fishermen of Lisbon, who were accustomed to empty a bottle of oil into the sea when they found on their return to the river that there was a dangerous surf on the bar, which might fill their boats in crossing it.

As regards Peterhead, it is proposed to lay perforated pipes across the mouth of the harbor, and to erect tanks from which these pipes may be supplied with oil, and thus pour a continuous and widely distributed stream into the sea in bad weather. The scheme was mooted some time ago, but I am not aware whether it has yet been carried out. Its success or failure must mainly be determined by the cost, and this will largely depend upon the kind of oil that is used. A series of well-conducted experiments upon the comparative areas protected by different kinds of oil would be very interesting and practically useful, for, until this has been ascertained, a proper selection cannot be made. How long will it last? is another question.

I have frequently seen such tracks as Franklin observed out at sea, and have climbed to the masthead in order to sight the ship that produced them without seeing any. Several of such smooth shining tracks have been observed at the same time, but no ship visible, and this in places where no sail has been seen for days before or after. The poet's description of "the trackless ocean" is by no means "founded on fact."

The Plymouth Breakwater contains 3,369,261 tons of stone, and cost the British Government a million and a half. The interest on this at 4 per cent amounts to 60,000*l.* per annum. If the above statements are reliable, some of the wholesale oil merchants who read this might contract to becalm a considerable area of the Channel for a smaller amount.

Further experiments have been made at Peterhead since the above was written. The following account, from the *Times* of those made on February 27, 1882, is interesting:

"On Monday the long-wished-for easterly gale to test the experiment of throwing oil on the troubled waters reached Peterhead. It may be mentioned that the harbor of Peterhead is singularly exposed, and with an east or north-east gale is very dangerous of approach. Mr. Shields, of Perth, has laid the oil apparatus to be used in quelling the troubled waters. It consists of an iron pipe which conveys oil and extends from a wooden house behind the sea-wall at Roanhead down through a natural gullet in the rocks about 150 yards long and about 50 yards beyond the mouth of the gullet into about seven fathoms of water; at this point the iron pipe is joined to a guttapercha pipe, which extends across the harbor entrance outside the bar and is perforated at distances 12½ yards apart. Through the guttapercha pipe the oil reaches the sea. On Monday the wind was not so strong as to make the experiment so complete as could have been wished; still, there was a heavy swell. Early in the forenoon the pumps were put in motion and the leakage space in the pipe filled; but unfortunately it was found, soon after the oil began to rise to the surface of the bay, that the supply in the cask had become exhausted, and those who were conducting the experiment did not consider themselves at liberty to order a fresh cask of oil without Mr. Shield's sanction. But while the experiment was only partial it was highly satisfactory. At the same time, the film did not extend sufficiently far to prevent the waves forming and curving to broken water. As soon, however, as they reached the oil-covered neck the observers from the pier-head could easily discern the influence at work. Waves which came in crested gradually assumed the shape of undulating bodies of water, and, once formed, they rolled unbroken towards the breakwater. On Wednesday morning there was a heavy sea at the north breakwater. The oil valves were opened, and immediately the effect was manifest. The waves, which had before dashed with fury against the breakwater, assumed a rolling motion and were quite crestless. Indeed, it was admitted that the oil had rendered the entrance comparatively safe, *but the effect was not so abiding as could have been wished.*"

As regards the want of duration there noted, I venture to make a suggestion.

Oils vary so greatly in their rate of outspreading over water and the character of the film they form, that some years ago Mr. Moffatt, of Glasgow, proposed to use these differences as a test for the adulterations of one kind of oil with other and cheaper kinds.

I made a number of experiments verifying some of his results.

From these it is evident that the duration of the becalming effect will vary with different oils, and therefore further experiments upon these difference should be made, in order to select that kind which is the most effective, with due regard, of course, to cost.

The oil indicated by my experiments as combining permanency and cheapness, and altogether the most suitable and attainable is the "*dead oil*" refuse of the gas-works. This may be used in its crude and cheapest condition.

ON THE SO-CALLED "CRATER NECKS" AND "VOLCANIC BOMBS" OF IRELAND.

A PAPER READ AT THE GEOLOGISTS' ASSOCIATION, DECEMBER 6, 1878.

MR. HULL, "Physical Geography and Geology of Ireland," p. 68, under the head of "Volcanic Necks and Basaltic Dykes," says that "although the actual craters and cones of eruption have been swept from the surface of the country by the ruthless hand of time, yet the old "necks" by which the volcanic mouths were connected with the sources of eruption can occasionally be recognized; they sometimes appear as masses of hard trap, columnar or otherwise, projecting in knolls or hills above the upper surface of the sheets through which they pierce."

In other cases, the "neck" consists of a great pipe choked up by bombs and blocks of trap, more or less consolidated, bombs which have been shot into the air and have fallen back again. He then refers to one of these near Portrush, and proceeds to state that the rock on which stands the ruined Castle of Dunluce, "is formed of bombs of all sizes up to six feet in diameter, of various kinds of basalt, dolerite, and amygdaloid firmly cemented, and presenting a precipitous face to the sea."

In a note dated September, 1877, Mr. Hull states that subsequent examination, since the above was written, of the rock of Dunluce Castle and the cliffs adjoining, has led him "to suspect that we have here, instead of old volcanic necks, simply pipes, formed by the filtration out of the chalk into which the basaltic masses have fallen and slipped down, thus giving rise to their fragmental appearance."

Further on (page 146) he describes without any sceptical comment, "the remarkable mass of agglomerate made up (as on the southern flanks of Slieve Gullion) of bombs of granite, which have been torn up from the granite mass of the hills below, and blown through the throat of an old crater." Other geologists still adhere firmly to the bomb theory, some ascribing the bombs to subaqueous rather than subaerial ejection.

Immediately under Dunluce Castle is a sea-worn cavern or tunnel, which is about 40 or 50 feet high at its mouth, affording a fine section of this curious conglomerate. The floor of the cavern which slopes upwards from the sea is strewn with a beach of boulders. The resemblance of this beach to those I had recently examined at the foot of the boulder-clay cliffs of Galway Bay (and described in a paper read to the British Association), suggested the explanation of the origin of the rock I am about to offer.

In shape and size they are exactly like the Galway shore boulders, those nearest the sea being the most rounded; higher up the slope, where less exposed to wave action, they are subangular. They differ from the Galway boulders in being chiefly basaltic instead of being mainly composed of carboniferous limestone. Some of these at Dunluce are granitic, and a few, if I am not greatly mistaken, are of carboniferous limestone. I had not at hand the means of positively deciding this.

Neither could I find any unquestionable examples of glacial striation among them, though at the upper part I saw some lines on boulders that were very suggestive of partially obliterated scratches.

On looking at the cavern walls surrounding me the theory so obviously suggested by the boulders on the floor was strikingly confirmed by their structure and general appearance. The imbedded "bombs" are subangular, and of irregular shape and varying composition, and the matrix of the rock is a brick-like material just such as would be formed by the baking of boulder clay; the inference that I was looking upon a bank or deposit of glacier drift that had been baked by volcanic agency was irresistible.

I was unable to see on any part of the extensive section, or among the fragments below, a single specimen of an unequivocal volcanic bomb; no approach to anything like those described by Sir Samuel Baker in his "Nile Tributaries of Abyssinia," the miniature representatives of which, ejected from the Bessemer converter, I have figured and described in *Nature*, vol. 3, pp. 389 and 410, where Sir Samuel Baker's description is quoted.

I have witnessed the fall of masses of lava during a minor eruption of an inner crater of Mount Vesuvius. These as they fell upon the ground around me were flattened out into thin cakes. There was no approach to the formation of subangular masses, like those displayed upon the Dunluce cavern walls.

Some years ago a project for melting the basaltic rock known as "Rowley Rag," and casting it into moulds for architectural purposes was carried out near Oldbury, and I had an opportunity of watching the experiment, which was conducted on a large scale at great expense by Messrs. Chance.

It was found that if the basalt cooled rapidly it became a black obsidian, and to prevent the formation of such brittle material, the castings, and the moulds, which enclosed them, had to be kept at a red-heat for some days, and very gradually cooled.*

It is physically impossible that lava ejected under water, in lumps no larger than these boulders, could have the granular structure which they display.

The fundamental idea upon which this bomb theory is based will not bear examination. Such bombs could not have been shot into either air or water and have fallen back again into the volcanic neck at any other time than during an actual eruption; and at such time they could not have remained where they fell, and have become embedded in any such matrix as now contains them. True volcanic bombs and ordinary spattering lumps of lava, are, as we know, flung obliquely out of active craters, and distributed around, while those which are ejected perpendicularly into the air and return are re-ejected, and finally pulverized into volcanic dust if this perpendicular ejection and return are continued long enough.

In the course of a rapid drive round the Antrim coast I observed other examples of this peculiar conglomerate, and have reason to believe that it is far more common than is generally supposed. I found it remarkably well displayed at a place almost as largely visited as the Giant's Causeway, and where it nevertheless appears to have been hitherto unnoticed, viz., Carrick-a-Rede, where the public car stops to afford visitors an opportunity of examining or crossing the rope bridge, etc.

Here the whole formation is displayed in a manner that strikingly illustrates my theory.

There is an overlying stream of basalt forming the surface of the isolated rock, and this basalt rests directly upon a base of conglomerate, having exactly the appearence that would result from the slow baking of a mass of boulder clay.

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* Geologists who may be interested in seeing the results of this experiment, will find on the Edgbaston Vestry Hall, in Enville Road, near the Five Ways, Birmingham, some columns, massive window pieces, doorways, and ornamental steps cast from the fused Rowley Rag and slowly cooled.

The sea gully that separates the insular rock from the mainland displays a fine section above eighty feet in thickness, and has the advantage of full daylight as compared with Dunluce Cave. That this is no mere neck or pipe is evident from its extent. Its position below the basalt cap refutes the above quoted subsequent explanation, which Mr. Hull and others have recently adopted.

The heterogeneous bomb-like character of the boulders is not so strongly marked as in the Dunluce rock, and this may arise from the closer proximity of the basalt, which, coming here in direct contact, would be likely to heat the clay matrix (itself formed mainly of ice-ground basalt) to incipient fusion, and thereby render it more like the basalt boulders it contains than the other clay that had been less intensely heated on account of greater distance from the lava-flow.

The path leading to the ladder by which the bridge is approached passes over such conglomerate, and further extensions are seen in sections around. I saw sufficient in the course of my hurried visit to indicate the existence of a large area of this particular formation.

At a short distance from Carrick-a-Rede, on the way to Ballycastle, the car passes in sight of considerable deposits of ordinary boulder clay uncovered and unaltered.

The blocks of basalt, etc., embedded in this correspond in general size and shape with the "bombs," excepting that some of the latter have a laminated, or shaly, character near their surfaces.

I regret my inability to do justice to this subject in consequence of the fact that the above explanation of the origin of this curious formation only suggested itself when hurrying homeward after a somewhat protracted visit to Ireland. As I may not have an opportunity of further investigation for some time to come, I offer the hypothesis in this crude form in order that it may be discussed, and either confirmed or refuted by the geologists of the Ordnance Survey, or others who have better opportunities of observation than I can possibly command.

Should this conglomerate prove to be, as I suppose, a drift deposit altered by a subsequent flow of lava, it will supply exceedingly interesting data for the determination of the chronological relations of the glacial epoch to that period of volcanic activity to which the lavas of the N.E. of Ireland are due. Though it will nowise disturb the general conclusion that the great eruptions that overspread the cretaceous rocks of this region, and supplied the boulders of my supposed metamorphosed drift, occurred during the Miocene period, it will show that this volcanic epoch was of vastly greater duration than is usually supposed; or that there must have been two or more volcanic epochs—pre-glacial, as usually understood, and post-glacial, in order to supply the lava overflowing the drift.

This post-glacial extension of the volcanic period has an especial interest in Ireland, as the "Annals of the Four Masters," and other records of ancient Irish history and tradition, abound in accounts of physical changes, many of which correspond remarkably with those of recent occurrence in the neighborhood of active and extinct volcanoes.

In a paper read before the Royal Irish Academy, June 23, 1873, and published in its "Proceedings," Dr. Sigerson has collected some of the best authenticated of these accounts, and compares them with similar phenomena recently observed in Naples, Sicily, South America, Siberia, etc. etc. The "great sobriety of diction, and circumstantial precision of statement," of names, dates, etc., which characterize these accounts render them well worthy of the sort of comparison with strictly scientific data which Dr. Sigerson has made.

As we now know that man existed in Britain during the inter-glacial, if not the pre-glacial period, and as so violent a volcanic disturbance as that which poured out the lavas of Antrim and the Mourne district could scarcely have subsided suddenly, but was probably followed by ages of declining activity, it is not at all surprising that this period of minor activity should have extended into that of tradition and the earliest of historical records.

TRAVERTINE.

The old exclamation about Augustus finding Rome of brick and leaving it of marble, deceives many. Ancient Rome was by no means a marble city, although the quarries of Massa and Carrara are not far distant. The staple-building materials of the Imperial City, even in its palmiest days, were brick and travertine. The brick, however, was very different from the porous cakes of crudely burnt clay of which the modern metropolis of the world is built. I have examined on the spot a great many specimens, and found them all to be of remarkably compact structure, somewhere between the material of modern terra-cotta and that of common flower-pots, and similarly intermediate in color. The Roman builders appear to have had no standard size; the bricks vary even in the same building—the Coliseum for example; all that I have seen are much thinner than our bricks—we should call them tiles.

But the most characteristic material is the travertine. The walls of the Coliseum are made up of a mixture of this and the tiles above-mentioned. The same is the case with most of the other very massive ruins, as the baths, etc. Many of the temples with columns and facing of marble have inner walls built of this mixture, while others are entirely of travertine.

I was greatly surprised at the wondrous imperishability of this remarkable material. In buildings of which the smooth crystalline marble had lost all its sharpness and original surface, this dirty, yellow, spongy-looking limestone remained without the slightest indication of weathering. A most remarkable instance of this is afforded by the temple of Neptune at Paestum, in Calabria. This is the most perfect ruin of a pure classic temple that now remains in existence, and in my opinion is the finest. I prefer it even to the Parthenon.

We have a little sample of it in London. The Doric columns at the entrance of the Euston station are copies of those of its peristyle. The originals are of travertine, the blocks forming them are laid upon each other without mortar or cement, and so truly flattened that in walking round the building and carefully prying, I could find no crevice into which a slip of ordinary writing paper, or the blade of a pen-knife could be inserted. Yet this temple was an antiquarian monument in the days of the Roman emperors.

The rough natural surface of the stone is exposed, and at first sight appears as though weathered, but this appearance is simply due to its natural sponge-like structure. It appears to have been coated with some sort of stucco or smoothing film, which, either by forming a thin layer, or possibly by only filling up the pores of the travertine, gave a smooth surface upon which the coloring was applied. This is now only indistinctly visible here and there, and if I remember rightly, some have disputed its existence.

But this travertine, though so familiar to the Italian, is such a rarity here that some further description of its structure and composition may be demanded. It is a limestone formed by *chemical* precipitation. Most limestones are more or less of organic origin, are agglomerations of shells, corals, etc., but this is formed by the same kind of action as that which produces the stalactites in limestone caverns. It has some resemblance to the incrustation formed on boilers by calcareous water. Although the material of so many ancient edifices, it is, geologically speaking, the youngest of all the hard rocks. Its formation is now in progress at some of the very quarries that supplied Imperial Rome.

On the Campagna, between Rome and Tivoli, is a small circular lake, from which a stream of tepid water, that wells up from below, is continually flowing. Its local name is the "The Lake of Tartarus." The water, like that of Zoedone, or soda-water or champagne, is supersaturated with carbonic acid that was forced into it while under pressure down below. This carbonic acid has dissolved some of the limestones through which the subterranean water passes, and when it comes to the surface, the carbonic acid flies away like that which escapes when we uncork a bottle of soda-water, though less suddenly, and the lime losing its solvent is precipitated, and forms a crust on whatever is covered by the water.

When I visited this lake in the month of February it was surrounded by a *chevaux de frise* of an extraordinary character; thousands of tubes of about half an inch to one inch in diameter outside, with calcareous walls about one eighth of an inch in thickness. These were standing up from two to three feet high, and so close together that we had to break our way through the dense palisade they formed in order to reach the margin of the lake. After some consideration and inquiry, their origin was discovered. They are the encrusted remains of bullrushes that had flourished in the summer and died down since. During the time of their growth the water had risen, and thus they became coated with a crust of compact travertine. This deposition takes place so rapidly that a piece of lace left in the lake for a few hours comes out quite stiff, every thread being coated with limestone. Such specimens, and twigs similarly covered, are sold to tourists or prepared by them if they have time to stop. Sir Humphry Davy drove a stick into the bottom of the lake and left it standing upright in the water from May to the following April, and then had some difficulty in breaking with a sharp pointed hammer the crust formed round the stick. This crust was several inches in thickness. That which I saw round the ex-bullrushes may have all been formed in a few days or weeks. The rivulet that flows from the lake deposits travertine throughout its course, and when it overflows leaves every blade of grass that it covers encrusted with this limestone.

Near to the Lake of Tartarus is the *Solfatara* lake which contains similar calcareous water, but strongly impregnated with sulphureted hydrogen; it consequently deposits a mixture of carbonate and sulphide of calcium, a sort of porous tufa, some of it so porous that it floats like a stony scum, forming what the cicerone call "floating islands." Lyell, in his "Principles of Geology," confounds these lakes, and describes Tartarus under the name of Solfatara.

The travertine used as a building stone is chiefly derived from the quarries of Ponte Lucano, and is the deposit that was formed on the bed of a lake like that of Tartarus. The celebrated cascade of the Anio at Tivoli forms calcareous stalactites, and all the country round has rivulets, caverns, and deposits, where this formation may be seen in progress or completed.

It varies considerably in structure, some specimens are compact and smooth, others have the appearance of a petrified moss, and great varieties may be found among the materials of a single building. It is, however, usually rough and more or less spongy-looking, as above stated, but this structure does not seem to affect its stability, at least, not in the climate of Italy. Whether it would stand long frosts is an open question. The night frosts at and about Rome are rather severe, but usually followed by a warm sunny day; thus there is no great penetration of ice.

Every specimen I have examined shows a remarkable compactness of *molecular* structure in spite of visible porosity. All give out a clear metallic ring when struck, and the intimate surface, if I may so describe the surface of the warm-like structure it sometimes displays, is always clear and smooth as though varnished. To this I attribute its durability. Lest the above description should appear self-contradictory, I will explain a little further. If melted glass were run into threads, and those threads while soft were allowed to agglomerate loosely into a convoluted mass, it would, as regarded in mass, have a porous or spongy-looking structure, but nevertheless its *molecular* structure would be compact and vitreous; there would be mechanical but not molecular, porosity. Travertine is similar.

Have we any travertine in England? This is a practical question of some importance, and one to which I have no hesitation in replying, Yes. There is plenty formed and forming in the neighborhood of Matlock, but that which I have seen on the face of caverns, etc., is not so compact and metal-like as the Italian. This, however, does not prove the entire absence of the useful travertine. Not having any commercial interest in the search, I have only looked at what has come in my way, but have little doubt that there are other kinds besides those I saw. I have also seen travertine in course of formation in Ireland, where I think there is a fine field for exploration in the mountain limestone regions, which have been disturbed by volcanic action of the Miocene period. The travertines of Italy are found in the neighborhood of extinct volcanoes.

The classic associations of this material, its remarkable stability, and the faculty with which it may be worked, render it worthy of more attention than it has yet received from British builders.

THE ACTION OF FROST IN WATER-PIPES AND ON BUILDING MATERIALS.

Popular science has penetrated too deeply now to render necessary any refutation of the old popular fallacy which attributed the bursting of water-pipes to the thaw following a frost; everybody now understands that the thaw merely renders the work of the previous freezing so disastrously evident. Nevertheless, the general subject of the action of freezing water upon our dwellings is not so fully understood by all concerned as it should be. Builders and house-owners should understand it thoroughly, as most of the domestic miseries resulting from severe winters may be greatly mitigated, if not entirely prevented, by scientific adaptation in the course of building construction. Now-a-days tenants know something about this and select accordingly. Thus the market value of a building may be increased by such adaptation.

Solids, liquids, and gases expand as they are heated. This great general law is, however, subject to a few exceptions, the most remarkable of which is that presented by water. Let us suppose a simple experiment. Imagine a thermometer tube with its bulb and stem so filled with water that when the water is heated nearly to its boiling point it will rise to nearly the top of the long stem. Now let us cool it. As the cooling proceeds the water will descend, and this descending will continue until it attains the temperature marked on our ordinary thermometer as 39°, or more strictly $39\frac{2}{10}$; then a strange inversion occurs.

As the temperature falls below this, the water rises gradually in the stem until the freezing point is reached.

This expansion amounts to $\frac{1}{7692}$ part of the whole bulk of the water, or 100,000 parts become 100,013. So far the amount of expansion is very small, but this is only a foretaste of what is coming. Lower the temperature still further, the water begins to freeze, and at the moment of freezing it expands suddenly to an extent equalling $\frac{1}{15}$ of its bulk, *i.e.*, of the bulk of so much water as becomes solidified. The temperature remains at 32° until the whole of the water is frozen.

Fortunately for us, the freezing of water is always a slow process, for if this conversion of every 15 gallons into 16 took place suddenly, all our pipes would rip open with something like explosive violence. But such sudden freezing of any considerable quantity of water is practically impossible, on account of the "latent heat" of liquid water, which amounts to 142½°. All this is given out in the act of freezing. It is this giving out of so much heat that keeps the temperature of freezing water always at 32°, even though the air around may be much colder. No part of the water can fall below 32° without becoming solid, and that portion which solidifies gives out enough heat to raise 142½ times its own quantity from 31° to 32°.

The slowness of thawing is due to the same general fact. An instructive experiment may be made by simply filling a saucepan with snow or broken ice, and placing it over a common fire. The slowness of the thawing will surprise most people who have not previously tried the experiment. It takes about as long to melt this snow as it would to raise an equal weight of water from 32° to 174°. Or, if a pound of water at 174° be mixed with a pound of snow at 32°, the result will be two pounds of water at 32°; 142° will have disappeared without making the snow any warmer, it will all have been used up in doing the work of melting.

The force with which the great expansion due to freezing takes place is practically irresistible. Strong pieces of ordnance have been filled with water, and plugged at muzzle and touch-hole. They have burst in spite of their great thickness and tenacity. Such being the case, it is at first sight a matter of surprise that frozen water-pipes, whether of lead or iron, ever stand at all. They would not stand but for another property of ice, which is but very little understood, viz., its *viscosity*.

This requires some explanation. Though ice is what we call a solid, it is not truly solid. Like other apparent solids it is not perfect rigid, but still retains some degree of the possibility of flowing which is the characteristic of liquids. This has been shown by filling a bombshell with water, leaving the fuse-hole open and freezing it. A shell of ice is first formed on the outside, which of course plugs up the fuse-hole. Then the interior gradually freezes, but the expansion due to this forces the ice out of the fuse-hole as a cylindrical stick, just as putty might be squeezed out, only that the force required to mould and eject the ice is much greater.

I have constructed an apparatus which illustrates this very strikingly. It is an iron syringe with cylindrical interior of about half an inch in diameter, and a terminal orifice of less than $\frac{1}{20}$ of an inch in diameter. Its piston of metal is driven down by a screw. Into this syringe I place small fragments of ice, or a cylinder of ice fitted to the syringe, and then screw down the piston. Presently a thin wire of ice is squirted forth like vermicelli when the dough from which it is made is similarly treated, showing that the ice is plastic like the dough, provided it is squeezed with sufficient force.

This viscosity of ice is displayed on a grand scale in glaciers, the ice of which actually flows like a river down the glacier valley, contracting as the valley narrows and spreading out as it widens, just as a river would; but moving only a few inches daily according to the steepness of the slope and the season, slower in winter than in summer.

Upon this, and the slowness of the act of freezing, depends the possibility of water in freezing in iron pipes without bursting them. Even iron yields a little before bursting, but ordinary qualities not sufficiently to bear the expansion of $\frac{1}{15}$ of their contents. What happens then? The cylinder of ice contained in the tube elongates as it freezes, provided always the pipe is open at one or both ends. But there is a limit to this, seeing that the friction of such a tight-fitting core, even of slippery ice, is considerable, and if the pipe be too long, the resistance of this friction may exceed the resistance of tenacity of the pipe. I am unable to give any figures for such length; the subject does not appear to have been investigated as it should be, and as it might well be by our wealthy water companies.

We all know that lead pipes frequently succumb, but a little observation shows that they do so only after a struggle. The tenacity of lead is much less than that of iron (about $\frac{1}{20}$ of that of ordinary wrought iron), but it yields considerably before breaking. It has, in fact, the property of viscosity similar to that of ice. At Woolwich the lead used for elongated rifle bullets is squirted like the ice in my syringe above described, powerful hydraulic pressure being used.

This yielding saves many pipes. It would save all *new* pipes if the lead were pure and uniform ; but as this is not the case, they may burst at a weak place, the yielding being shown by the bulge that commonly appears at the broken part.

From the above it will be easily understood that a pipe which is perfectly cylindrical—other conditions equal—will be less likely to burst than one which is of varying diameter, as the sliding from a larger to a smaller portion of the pipe must be attended with great resistance, or a certain degree of block, beyond what would be due to the mere friction along a pipe of uniform diameter.

Let us now consider the relative merits of lead and iron as material for water-pipes in places where exposure to frost is inevitable. Lead yields more than iron, and so far has an advantage; this, however is but limited. As lead is practically inelastic, every stretch remains, and every stretch diminishes the capacity for further stretching; the lead thus stretched at one frost is less able to stretch again, and has lost some of its original tenacity. Hence the superiority of new leaden pipes. Iron is elastic within certain limits, and thus the iron pipe may yield a little without permanent strain or "distress," and if its power of elastic resistance is not exceeded, it regains its original size without becoming sensibly weaker. Add to this its great tenacity, its non-liability to be indented, or otherwise to vary in diameter, and we have a far superior material.

But this conclusion demands some qualification. There is iron and iron, cast-iron and wrought-iron, and very variable qualities of each of these. I need scarcely add that common brittle cast-iron is quite out of the question for such purposes, though there is a new kind of cast-iron or semi-steel coming forward that may possibly supersede all other kinds; but this opens too wide a subject for discussion in the present paper, the main object of which has been a popular exposition of the general physical laws which must be obeyed by the builder, or engineer, who desires to construct domestic or other buildings that will satisfy the wants of intelligent people.

The mischievous action of freezing water is not confined to the pipes that are constructed to receive or convey it. Wherever water may be, if that water freezes, it must expand in the degree and with the force already described. If it penetrates stone or brick, or mortar or stucco, and freezes therein, one of two things must occur—either the superfluous ice must exude at the surface or to neighboring cavities, or the saturated material must give way, and split or crumble according to the manner and degree of penetration. To understand this, the reader must remember what I stated about the little-understood *viscosity* of ice, as well as its expansion at the moment of freezing.

Bricks are punished, but not so severely as might be anticipated, seeing how porous are some of the common qualities, especially those used in London. They are so amply porous that the water not only finds its way into them, but the pores are big enough and many enough for the ice to demonstrate its viscosity by squeezing out and displaying its crystalline structure in the form of snow-like efflorescence on the surface. This may have been observed by some of my readers during a severe frost. It is commonly confounded with the hoar-frost that whitens the roofs of houses, but which is very rarely deposited on perpendicular wall faces.

The mortar most liable to suffer is that which is porous and pulverulent within, but has been cleverly faced or pointed with a crust of more compact material. This outer film prevents the exuding of the expanding ice crystals, is thrust forth bodily, and retained by ice-cement during the frost, but it falls in scales when this temporary binding material thaws. Mortar that is compact throughout does not suffer to any appreciable extent. This is proved by the condition of the remains of Roman brickwork that still exist in Britain and other parts of Europe. Some of the old shingle walls at Brighton and other parts of the south coast, where the chalk for lime-burning was at the builder's feet, and where his mortar is so thickly laid between the irregular masses of flint, also show the possible duration of good mortar. The jerry builder's mortar, made of the riddlings of burnt clay ballast and dust-hole refuse just flavored with lime, crumbles immediately, because these materials do not combine with the lime as fine siliceous sand gradually does, to form an impermeable glassy silicate.

Stucco is punished by two distinct modes of action. The first is where the surface is porous, and the water permeates accordingly and freezes. This, of course, produces superficial crumbling, which should not occur at all upon good material protected by suitable paint. The other case, very deplorable in many instances, is where the water finds a space between the inner surface of the stucco and the outer surface of the material upon which it is laid. This water, when frozen, of course, expands, and wedges away the stucco bodily, causing it to come down in masses at the thaw. This, however, only occurs after severe frosts, as the ordinary mild frosts of our favored climate seldom endure long enough to penetrate to any notable depth of so bad a conductor as stone or stucco. It is worthy of note that water is a still worse conductor than stone.

Building stones are so various both in chemical composition and mechanical structure that the action of freezing water is necessarily as varied as the nature of the material. The highly siliceous granites (or, rather, porphyries that commonly bear the name of granite) are practically impermeable to water so long as they are free from any chemical decomposition of their feldspathic constituents; but when we come to sandstones and limestones, or intermediate material, very wide differences prevail.

The possible width of this difference is shown in the behavior of the unselected material in its natural home. Certain cliffs and mountains have stood for countless ages almost unchanged by the action of frost; others are breaking up with attonishing rapidity in spite of apparent solidity of structure. The Matterhorn, or Mont Cervin, one of the most gigantic of the giant Alps, 15,200 feet high, is rendered especially dangerous to ambitious climbers by the continual crashing down of fragments that are loosened when the summer sun melts the ice that first separated and then for a while held them in their original places. All the glaciers of the Alps are more or less streaked with "moraines," which are fragments of the mountains that freezing water has detached.

Our stone buildings would suffer proportionally if some selection of material were not made. Generally speaking, this selection is based upon the experience of previous practical trials. Certain quarries are known to have supplied good material of a certain character, and this quarry has, therefore, a reputation which is usually of no small value to its fortunate owner. Other quarries are opened in the neighborhood wherever the rock resembles that of the tested quarry.

Sometimes, however, materials are open for selection that have not been so well tested, and a method of testing which is more expeditious and less expensive than constructing a building and watching the result, is very desirable. The subject of testing building materials in special reference to their resistance of frost was brought before the Academy of Science of Paris by M. Brard some years since.

In his preliminary experiments he used small cubes of the stone to be tested, soaked them in water, and then exposed them to the air in frosty weather, or subjected them to the action of freezing mixtures. Afterwards he found that by availing himself of the expansive force which certain saline solutions exert at the moment of crystallization, he could conveniently imitate the action of freezing without the aid of natural or artificial frost. Epsom salts, nitre, alum, sulphate of iron, Glauber's salts, etc., were tried. The last named, Glauber's salt (or sulphate of soda), which is very cheap, was found to be the best for the purpose.

His method of applying the test is as follows: Cut the specimens into two-inch cubes, with flat sides and sharp edges and corners, mark each specimen with a number, either by ink or scratching, and enter in a book all particulars concerning it. Make a saturated solution of the sulphate of soda in rain or distilled water, by adding the salt until no more will dissolve; perfect saturation being shown by finding, after repeated stirring, that a little of the salt remains at the bottom an hour or two after the solution was made. Heat this solution in a suitable vessel, and when it boils put in the marked specimens one by one, and keep them immersed in the boiling solution for half an hour. Take out the specimens separately and suspend them by threads, each over a separate vessel containing some of the liquid in which they were boiled, but which has been carefully strained to free it from any solid particles. In the course of a day or two, as the cubes dry, they will become covered with an efflorescence of snow-like crystals; wash these away by simply plunging the specimen into the vessel below, and repeat this two or three times daily for four or five days or longer. The most suitable vessel for the purpose is a glass "beaker," sold by vendors of chemical apparatus.

In comparing competing samples, be careful to treat all alike, *i.e.*, boil them together in the same solution, and dip them an equal number of times at equal intervals.

Having done this, the result is now to be examined. If the stone is completely resistant the cube will remain smooth on its surfaces and sharp at its edges and corners, and there will be no particles at the bottom of the vessel. Otherwise, the inability of the stone to resist the test will be shown by the disfigurement of the cube or the small particles wedged off and lying at the bottom of the liquid.

Care must be taken not to confound these with crystals of the salt which may also be deposited. These crystals are easily removed by adding a little more water or warming the solution.

For strict comparison the fragments thus separated should be weighed in a delicate balance, such as is used in chemical analysis.

THE CORROSION OF BUILDING STONES.

About fifty years ago two eminent French chemists visited London, and rather "astonished the natives" by a curious feature of their dress. They wore on their hats large patches of colored paper. Coming, as they did, from Paris, many supposed that this was one of the latest Paris fashions, and the dandies of the period narrowly escaped the compulsion to follow it. They probably would have done so had the Frenchmen shown any attempt at decorative shaping of the paper. They neglected this because it was litmus paper, and their object in attaching it to their hats was to test the impurities of the London atmosphere.

Blue litmus paper, as everybody knows now-a-days, turns red when exposed to an acid. The French chemists found that their hat-decorations changed color, and indicated the presence of acid in the air of London; but when they left the metropolis and wandered in the open fields their blue litmus paper retained its original color. By using alkaline paper they contrived to collect enough of the acid to test its composition. They found it to be the acid which is formed by the burning of sulphur, and attributed its existence to the sulphur of our coal. At this time the domestic use of coal was scarcely known in Paris.

Subsequent experiments have proved that they were right; that the air of London contains a very practical quantity of sulphurous and sulphuric acids, which are due to the combustion of that yellow shining material more or less visible in most kinds of coal, and has been occasionally supposed to be gold. It is iron pyrites, a compound of iron and sulphur. When heated the sulphur is separated and burns, producing sulphurous acid, which, exposed to moist air, gradually takes up more oxygen and becomes sulphuric acid, which in concentrated solution is oil of vitriol. In the air it is very much diluted by diffusion, but is still strong enough to do mischief to some kinds of building materials.

In manufacturing towns, such as Birmingham and Sheffield, the quantity of this acid in the air is much greater than in London, and there its mischief is consequently more distinctly visible. The church of St. Philip, which stands nearly in the middle of Birmingham, and is surrounded by an old churchyard, was so corroded by this acid that the stone peeled away on all sides, and its condition was most deplorable. The tombstones were similarly disintegrated on their surfaces, and inscriptions quite obliterated. It became so bad that a few years ago restoration was necessary, and it was newly faced accordingly.

Some of the old tombstones that are preserved may still be seen against the church wall, and their peculiar structure is well worthy of study. They display a lamination or peeling away due to unequal corrosion, certain layers of the material of the stone having been evidently eaten away more rapidly than others. Anybody visiting Birmingham may easily examine these, as St. Philip's churchyard is situated between the two railway stations of New Street and Snow Hill, and is but two minutes' walk from either.

Other stone buildings in the town have suffered, but in very different degrees, and some have quite escaped, proving the necessity of careful selection of material wherever coal fires abound. In Birmingham the action of coal fires is assisted by other sources of acid vapor. The process of "pickling" brass castings, *i.e.*, brightening their surface, by dipping first in common nitric acid ("pickle acky") and then in water, is attended with considerable evolution of acid fumes. Besides this very widespread use of acid, there are several chemical manufactories that throw still more acid into the air immediately surrounding them.

As an example of the action of the atmospheric acids of

London upon building stones, I have but to name the Houses of Parliament, which have only been rescued from superficial ruin by the patchwork replacing of certain blocks of stone, and various devices of siliceous and other washings that have been carried out at great cost to the nation. That such an unsuitable material should have been used is disgraceful to all concerned. The ruin commenced before the building was finished. At the time when its erection commenced there were abundant evidences of the ruinous action of London atmosphere on some kinds of stone and the capability of others to resist it, for while many modern buildings are peeling and crumbling, some of the oldest in the midst of the city show scarcely any signs of corrosion.

The Birmingham and Midland Institute was established and in practical operation a few years before the present noble building was erected. I was the first teacher there and conducted the Science classes in the temporary premises in Cannon street. Having observed with some interest the disintegration of St. Philip's Church and other buildings, I was anxious for the safety of the new Institute buildings, and accordingly made some experiments upon the material proposed to be used by the architect. My method of testing was very simple, and as the practical esult has verified my anticipations I think it might be dopted by others.

First, I immersed some lumps of the stone in moderately strong solutions of sulphuric and hydrochloric acids sucessively, and observed whether any visible action occurred fter some days. There was none. I then roughly tested he crushing pressure of small samples in their natural tate, and subjected similar sized pieces to the same test fter they had been immersed in the acids. I found thus hat there were no evidences of internal disintegration even fter several days' immersion, and therefore inferred that he stone would stand the acid vapors of the Birmingham tmosphere. This has been the case with that portion of he building that was built of the material I tested. As I now nothing of the stone which is used for the extension f the building under the present architect, Mr. Chamber-lain, I am unable to make any forecast of its probable durability.

The experiments I made at the time named with this and other building materials justified the conclusion that the worst of all material for exposure to acid atmospheres is a sandstone, the particles of which are held together by limestone, or are otherwise surrounded by or intermingled with limestone; and that the best of *ordinary* material is a pure sandstone quite free from lime. I do not here consider such luxurious material as granite or porphyries.

Compact limestone, such as good homogeneous marble, stands fairly well, although it is slowly corroded. The corrosion, however, in this case, is purely superficial and tolerably uniform. It is a very slow washing away of the surface, without any disintegration such as occurs where a small quantity of limestone acts as binding material to hold together a large quantity of siliceous or sandy material, and where the agglomeration is porous, and the stone is so laid that a downward infiltration of water can take place; for it must be remembered that although the acid originally exists as vapor in the air, it is taken up by the falling rain, and the mischief is directly done to the stone by the acidified water. This, of course, is very weak acid indeed. That which I used for testing the stone was many thousand times stronger, but then I exposed the stone for only a few days instead of many thousand days.

As above stated, my experiments were but rude, but I think it would be quite worth while to construct crushing apparatus capable of registering accurately the pressure used, and to operate with standard solutions of acid upon carefully squared blocks of standard size, and thus to make comparative tests of various samples of stone when competitions for building materials are offered. In the case of the Birmingham and Midland Institute building there was no such competition, the choice was left entirely to the architect, and my examination was unofficially conducted upon the material already chosen with the intent of protesting if it failed. As it stood the test I merely reported the results informally to the architect, the late Sir Edward Barry, no further action being demanded.

FIRE-CLAY AND ANTHRACITE.

For household fire-places, whether open or closed, these may be regarded as the material and the fuel of the future, and should be more generally and better understood than they are.

The merits of fire-clay were fully appreciated and described nearly a hundred years ago by that very remarkable man, Benjamin Thompson, Count of Rumford. Any sound scientific exposition of the relative value of fire-clay and iron as fire-place materials can be little more or less than a repetition of what he struggled to teach at the beginning of the present century.

It is impossible to fairly understand this subject unless we start with a firm grasp of first principles. The business before us is to get as much heat as possible from fuel burning in a certain fashion, and to do this with the smallest possible emission of smoke.

Substances that are hotter than their surroundings communicate their excess of temperature in three different ways; 1st, by *Conduction;* 2d, by *Convection;* 3d, by *Radiation.* All of these are operating in every form of fire-place, but in very different proportions according to certain variations of construction.

To demonstrate the conduction of heat, hold one end of a pin between the finger and thumb, and the other end in the flame of a candle. The experiment will terminate very speedily. Then take a piece of a lucifer match of the same length as the pin, and hold that in the candle. This may become red-hot and flaming without burning the fingers, as the pin did at a much lower temperature. It matters not whether the pin be held upwards, downwards, or sideways, the heat will travel throughout its substance, and this sort of traveling is called "conduction," and the pin a "conductor" of heat. The conducting power of different substances varies greatly, as the above experiment shows. Metals generally are the best conductors, but they differ among themselves; silver is the best of all, copper the next. Calling (for comparison sake) the conductivity of silver 1000, that of copper is 736, gold 532, brass 236, iron 119, marble and other building stones 6 to 12, porcelain 5, ordinary brick earth only 4, and fire-brick earth less than this. Thus we may at once start upon our subject, with the practical fact that iron conducts heat thirty times more readily than does fire-brick.

Convection is different from conduction, inasmuch as it is effected by the movements of the something which has been heated by contact with something else. Water is a very bad conductor of heat, much worse than fire-brick, and yet, as we all know, heat is freely transmitted by it, as when we boil water in a kettle. If, however, we placed the water in a fire-clay kettle, and applied the heat at the top we should have to wait for our tea until to-morrow or the next day. When the heat is applied below, the hot metal of the kettle heats the bottom film of water by *direct contact;* this film expands, and thus, being lighter, rises through the rest of the water, heating other portions by contact as it meets them, and so on throughout. The heat is thus conveyed, and the term "convection" is based on the view that each particle is a carrier of heat as it proceeds. Air conveys heat in the same manner; so may all gases and liquids, but no such convection is possible in solids. The common notion that "heat ascends" is based on the well-known facts of convection. It is the heated gas or liquid that really ascends. No such preference is given to an upward direction, when heat is conducted or radiated.

Radiation is a flinging off of heat in all directions by the heated body. Radiation from solids is mainly superficial, and it depends on the nature of the heated surface. The rougher and the more porous the surface of a given substance the better it radiates. Bright metals are the worst radiators; lampblack the best, and fire-brick nearly equal to it. To show the effect of surface, take three tin canisters of equal size, one bright outside, the second scratched and roughened, the third painted over with a thin coat of lampblack. Fill each with hot water of the same temperature, and leave them equally exposed. Their rates of radiation will then be measurable by their rates of cooling. The black will cool the most rapidly, the rough canister next, and the bright one the slowest.

Radiant heat may be reflected like light from bright surfaces, the reflecting substance itself becoming heated in a proportion which diminishes just as its reflecting powers increase. Good reflectors are bad radiators and bad absorbers of heat, and the power of *absorbing* heat, or becoming superficially hot when exposed to radiant heat, is exactly proportionate to radiating efficiency.

Fire-clay is a good absorber of radiant heat, *i.e.*, it becomes readily heated when near to hot coals or flames, without requiring actual contact with them. It is an equally good radiator.

Let us now apply these facts to fire-clay in fireplaces, beginning with ordinary open grates used for the warming of apartments; first supposing that we have an ordinary old-fashioned grate all made of iron—front, sides, and back, as well as bars, and next that we have another of similar form and position, but all the fire-box and the back and cheeks of the grate made of fire-clay.

It is evident that the fire-clay not in actual contact with the coals, but near to them, will absorb more heat than the iron, and thus become hotter. Even at the same temperature it will radiate much more heat than iron, but being so much hotter this advantage will be proportionately increased. An open fireplace lined throughout with fire-clay thus throws into the room a considerable amount of its own radiation in addition to that thrown out from the coal.

But what becomes of this portion of the heat when the fireplace is all of metal? It is carried up the chimney by convection, for the metal, while it parts with less heat by radiation, gives up more to the air by direct contact. Therefore, if we must burn our coals inside the chimney, we lose less by burning them in a fire-clay box than in a metal box.

Count Rumford demonstrates this, and described the best form of open firegrate that can be placed in an ordinary English hole-in-the-wall fireplace. The first thing to be done, according to his instructions, is to brick up your large square fireplace recess, so that the back of it shall come forward to about 4 inches from the front inside face of the chimney. thus contracting the *throat* of the chimney, just behind the mantel, to this small depth (Rumford's device for sweeping need not be here described). The sides or "covings" of this shallowed recess are now to be sloped inwards so that each one shall horizontally be at an angle of 135 deg. to the plane of this new back, and meet it at a distance of six or more inches apart, according to the size of grate required. The covings will thus spread out at right angles with each other, and leave an annular opening to be lined with fire-brick, and run straight up to the chimney. The fire-bars and grate-bottom to be simply let into this as far forward as possible.

By this simple arrangement we get a fire-grate with a narrow flat back and out-sloping sides; all these three walls are of fire-brick; the back radiates perpendicularly across the room; and the sloping sides radiate outwards, instead of merely across the fire from one to the other, as when they are square to the walls.

At Rumford's time our ordinary fireplaces were square recesses; now we have adopted something like his suggestion in the sloping sides of our register grates, and we bring our fireplaces forward. We have gone backwards in material, by using iron, but this, after all, may be merely due to the ironmongery interest overpowering that of the bricklayers. The preponderance of this interest in the South Kensington Exhibition may account for the fact that Rumford's simple device was not to be seen in action there. It could not pay anybody to exhibit such a thing, as nobody can patent it, and nobody can sell it. I have seen the Rumford arrangement carried out in office fireplaces with remarkable success. To apply it anywhere requires only an intelligent bricklayer, a few bricks, and some iron bars.

Although nobody exhibited this, a very near approach to it was described in an admirable lecture delivered at South Kensington, by Mr. Fletcher, of Warrington. In one respect Mr. Fletcher goes further than Count Rumford in the application of fire-clay. He makes the bottom of the fire-box of a slab of fire-clay instead of ordinary iron fire-bars.

This demands a little more trouble and care in lighting the fire, owing to the absence of bottom-draught, but when the fire is well started the advantages of this further encasing in fire-clay are considerable. They depend upon another effect of the superior radiant and absorbent properties of fire-clay that I will now explain.

So far, I have only described the beneficial effect of its radiation on the room to be heated, but it performs a further duty inside the fireplace itself. Being a bad conductor, it does not readily carry away the heat of the burning coal that rests upon it, and being also an excellent absorber, it soon becomes very hot—*i.e.*, superficially hot, or hot where its heat is effective. This action may be seen in a common register stove with fire-clay back and iron sides. When the fire is brisk the back is visibly red-hot, while the sides are still dull. If, after such a fire has burnt itself out, we carefully examine the ashes, there will be found more fine dust in contact with the fire-brick than with the iron—*i.e.*, evidence of more complete combustion there; and one of the advantages justly claimed by Mr. Fletcher is, that with his solid fire-clay bottom there will be no unburnt cinders—nothing left but the incombustible mineral ash of the coal. Economy and abatement of smoke are the necessary concomitants of such complete combustion.

A valuable "wrinkle" was communicated by Mr. Fletcher. The powdered fire-clay that is ordinarily sold is not easily applied on account of its tendency to crumble and peel off the back and sides of the stove after the first heating. In order to overcome this, and obtain a fine compact lining, Mr. Fletcher recommends the mixing of the fire-clay powder with a solution of water-glass (silicate of soda) instead of simple water. It acts by forming a small quantity of glassy silicate of alumina, which binds the whole of the clay together by its fusion when heated.

Londoners, and, in fact, Englishmen generally, have hitherto regarded anthracite as a museum mineral and a curiosity, rather than an everyday coal-scuttle commodity. If it is to be the fuel of the future, it is very desirable that we should all know something about its merits and demerits, as well as the possibilities of supply.

Anthracite is a natural coke. From its position in the earth, and its relations to bituminous coal, as well as from its composition, we are justified in regarding it as a coal that was originally bituminous, but which has been altered by heat, acting under great pressure. In the great coalfield of South Wales, to which we must look for our main supply of anthracite, we are able to trace the action of heat in producing a whole series of different classes of coal in a single seam, which at one part is highly bituminous—soft, flaming coal, like the Wallsend, then it becomes harder and less bituminous, then semi-bituminous "steam coal," then less and less flaming, until at last we have the hard, shiny form of purely carbonaceous coal, that may be handled without soiling the fingers, and which burns without flame, like coke or charcoal. This change proceeds as the seam extends from the east towards the west. In some places the coal at the base of a hill may be anthracite, while that on the outcrop above it may be bituminous.

An artificial anthracite may be made by heating coal in a closed vessel of sufficient strength to resist the expansion of the gases that are formed. It differs from coke in being compact, is not porous, and therefore, of course, much denser, a given weight occupying less space.

That we Englishmen should be about the last of all the coal-using peoples to apply anthracite to domestic purposes is a very curious fact, but so it is. In America it is the ordinary fuel, and this is the case in all other countries where it is obtainable at the price of bituminous coal. Our perversity in this respect shows out the more strikingly when we go a little further into the subject by comparing the two classes of coal in reference to our methods of using them, and when we consider the fact that our South Wales anthracite is far superior to the American.

Our open fires only do their small fraction of useful work by radiation. Their convection is all up the chimney. Such being the case, and we being theoretically regarded as rational beings, it might be supposed that for our national and especially radiating fireplaces we should have selected a coal of especial radiating efficiency, but, instead of this, we do the opposite. The flaming coal is just that which flings the most heat up the chimney, and the least into the room, and, as though we were all struggling to destroy as speedily as possible the supposed physical basis of our prosperity, we select that coal which in our particular fire-places burns the most wastefully. If we had closed iron stoves with long stove-pipes in the room, giving to the air the heat they had obtained by the convective action of the flame and smoke, there might be some reason for using the flaming coal, as the flame would thereby do useful work, but, as it is, we stubbornly persist in using only the radiated heat, and at the same time select just the coal which supplies the smallest quantity of what we require.

No scientific dissertation is necessary to prove the superior radiating power of an anthracite fire to anybody who has ever stood in the front of one. This is most strikingly demonstrated by those grates that stand well forward, and are kept automatically filled with the radiant-carbon.

Let us now see *why* anthracite is a better radiator than bituminous coal. This is due to its chemical composition. Of all the substances that we have upon the earth carbon in its ordinary black form is the best radiator. Anthracite contains from 90 to 94 per cent of pure carbon, bituminous coal from 70 to 85, and much of this being combined with hydrogen burns away as flame. On a rough average we may say that the fixed or solid carbon capable of burning with a smokeless flameless glow, amounts to 65 per cent in ordinary British bituminous coal, against an average of 92 per cent in British anthracite. The advantages of anthracite as a fuel for open radiating grates are nearly in the proportion of these figures. Besides this it contains about half the quantity of ash. Thus we see that from a purely selfish point of view, and quite irrespective of our duty to our fellow-citizens as regards polluting the atmosphere, anthracite is preferable to ordinary coal on economical grounds, supposing we can obtain it at the same price as bituminous coal, which is now the case.

Another great advantage of anthracite is its cleanliness, It may be picked up in the fingers without soiling them, and it is similarly cleanly throughout the house. It produces no "blacks," no grimy dust, and if it were generally in use throughout London one half of the house-cleaning would be saved. White curtains, blinds, etc., might hang quite four times as long, and then come down not half so dirty as now. The saving in soap alone, without counting labor, would at once return a handsome percentage on the capital outlay required for reconstructing all our fireplaces.

Let us now look on the other side, and ask what are the disadvantages of anthracite, and why is it not at once adopted by everybody? There is really only one disadvantage, viz., the greater difficulty of starting an anthracite fire. Practically this is considerable, seeing that laziness is universal and ever ready to find excuses when an innovation is proposed that stands in its way. To light an anthracite fire in an ordinary fireplace the bellows are required unless a specially suitable draught or fire-lighter is used. Some recommend that an admixture of bituminous coal should be used to start it, but this is a feeble device calculated to lead to total failure, seeing that the sole originator and sustainer of our ordinary use of bituminous coal is domestic ignorance and indolence, and if both kinds of coal are kept in a house a common English servant will stubbornly use the easy-lighting kind, and solemnly assert that the other cannot be used at all. The only way to deal with this obstacle, the human impediment, is to say, "This you must use, or go." This is strictly just, as a simple enforcement of duty.

At the same time some help should be supplied in the way of artificial modes of creating a draught in starting an anthracite fire. This may be done by temporarily closing the front of the fire by a "blower," or better still by selecting one of the grates specially devised for burning anthracite, of which so many now are made. Another and rather important matter is to obtain the anthracite in suitable condition. It is a very hard coal, too hard to be broken by the means usually at hand in ordinary houses. For domestic purposes it should always be delivered broken up of suitable size, from that of an egg to a cocoa-nut. For furnaces, of course, large lumps are preferable.

Then, again, anthracite must not be stirred and poked about; once fairly started it burns steadily and brightly, demanding only a steady feeding. The best of the special grates are more or less automatic in the matter of feeding, and thus the trouble of lighting is fully compensated by the absence of any further trouble.

As regards the supply. This for London and the greater part of England will doubtless be derived from the great coal-field of South Wales. The total quantity of available coal in this region after deducting the waste in getting, was estimated by the Government Commissioners at 32,456 millions of tons. It is very difficult or impossible to correctly estimate the proportion of anthracite in this, but supposing it to be one tenth of true anthracite it gives us 3245 millions of tons, or about enough for the domestic supply of the whole country during 100 years, assuming that it shall be used less wastefully than we are now using bituminous coal, which would certainly be the case. But, including the imperfect anthracite, the quantity must be far larger than this, and we have to add the other sources of anthracite.

We need not, therefore, have any present fear of insufficient supply ; probably before the 100 years are ended we shall find other sources of anthracite, or even have become sufficiently civilized to abolish altogether our present dirty devices, and to adopt rational methods of warming and ventilating our houses. When we do this any sort of coal may be used.

COUNT RUMFORD'S COOKING-STOVES.

In the preceding chapter I described Count Rumford's modification of the English open firegrate which eighty years ago was offered to the British nation without any patent or other restrictions. Its non-adoption I believe to be mainly due to this—it was nobody's monopoly, nobody's business to advertise it, and, therefore, nobody took any further notice of it; especially as it cannot be made and sold as a separate portable article.

An ironmonger or stove-maker who should go to the expense of exhibiting Rumford's simple structure of firebricks and a few bars, described in the last chapter, would be superseding himself by teaching his customers how they may advantageously do without him.

The same remarks apply to his stoves for cooking purposes. They are not iron boxes like our modern kitcheners, but are brick structures, matters of masonry in all but certain adjuncts, such as bars, fire-doors, covers, oven-boxes, etc., which are very simple and inexpensive. Even some of Rumford's kitchen utensils, such as the steamers, were cheaply covered with wood, because it is a bad conductor, and therefore wastes less heat than an iron saucepan lid.

Rumford was no mere theorist, although he contributed largely to pure science. His greatest scientific discoveries were made in the course of his persevering efforts to solve practical problems. I must not be tempted from my immediate subject by citing any examples of these, but may tell a fragment of the story of his work so far as it bears upon the subject of cooking-ranges.

He began life as a poor schoolmaster in New Hampshire, when it was a British colony. He next became a soldier; then a diplomatist; then in strange adventurous fashion he traveled on the Continent of Europe, entered the Bavarian service and began his searching reform of the Bavarian army by improving the feeding and the clothing of the men. He became a practical working cook in order that they should be supplied with good, nutritious, and cheap food.

But this was not all. He found Munich in a most deplorable condition as regards mendicity; and took in hand the gigantic task of feeding, clothing, and employing the overwhelming horde of paupers, doing this so effectually that he made his "House of Industry" a true workhouse; it paid all its own expenses, and at the end of six years left a net profit of 100,000 florins.

I mention these facts in conformation of what I said above concerning his practical character. Economical cookery was at the root of his success in this maintenance of a workhouse without any poor-rates.

After doing all this he came to England, visited many of our public institutions, reconstructed their fireplaces, and then cooked dinners in presence of distinguished witnesses, in order to show how little need be expended on fuel, when it is properly used.

At the Foundling Institution in London he roasted 112 lbs. of beef with 22 lbs. of coal, or at a cost of less than threepence. The following copy of certificate, signed by the Councillor of War, etc., shows what he did at Munich: "We whose names are underwritten certify that we have been present frequently when experiments have been made to determine the expense of fuel in cooking for the poor in the public kitchen of the military workhouse at Munich, and that when the ordinary dinner has been prepared for 1000 persons, the expense for fuel has not amounted to quite 12 kreutzers." Twelve kreutzers is about 4½*d.* of our money. Thus only 1-50th of a farthing was expended on cooking each person's dinner, although the peas which formed the substantial part of the soup required five hours, boiling. The whole average daily fuel expenses of the kitchen of the establishment amounted to 1-20th of a farthing for each person, using wood, which is much dearer than coal. At this rate, *one ton of wood should do the cooking for ten persons during two years and six days, or one ton of coal would supply the kitchen of such a family three and a half years.*

The following is an abstract of the general principles which he expounds for the guidance of all concerned in the construction of cooking stoves.

1. All cooking fires should be enclosed.

2. Air only to be admitted from below and under complete control. All air beyond what is required for the supply of oxygen "is a thief."

3. All fireplaces to be surrounded by non-conductors, *brickwork, not iron.*

4. The residual heat from the fireplace to be utilized by long journeys in returning flues, and by *doing the hottest work first.*

5. Different fires should be used for different work.

The first of these requirements encounters one of our dogged insular prejudices. The slaves to these firmly believe that meat can only be roasted by hanging it up to dry in front of an open fire; their savage ancestors having held their meat on a skewer or spit over or before an open fire, modern science must not dare to demonstrate the wasteful folly of the holy sacrifice. Their grandmothers having sent joints to a bakehouse, where other people did the same, and having found that by thus cooking beef, mutton, pork, geese, etc., some fresh, and some stale. in the same oven, the flavors became somewhat mixed, and all influenced by sage and onions, these people persist in believing that meat cannot be roasted in any kind of closed chamber.

Rumford proved the contrary, and everybody who has fairly tried the experiment knows that a properly ventilated and properly heated roasting oven produces an incomparably better result than the old desiccating process.

Rumford's roaster was a very remarkable contrivance, that seems to have been forgotten. It probably demands more intelligence in using it than is obtainable in a present-day kitchen. When the School Boards have supplied a better generation of domestic servants we may be able to restore its use.

It is a cylindrical oven with a double door to prevent loss of heat. In this the meat rests on a grating over a specially constructed gravy and water dish. Under the oven are two "blow-pipes," *i.e.*, stout tubes standing just above the fire so as to be made red hot, and opening into the oven at the back, and above the fireplace in front, where there is a plug to be closed or open as required. Over the front part of the top of the oven is another pipe for carrying away the vapor. It is thus used: The meat is first cooked in an atmosphere of steam formed by the boiling of water placed in the bottom of the double dish, over which the meat rests. 'When by this means the meat has been raised throughout its whole thickness to the temperature at which its albumen coagulates, the plugs are removed from the blow-pipes, and *then* the special action of roasting commences by the action of a current of superheated air which enters below and at the back of the oven, travels along and finds exit above and in front of the steam-pipe before named.

The result is a practical attainment of theoretical perfection. Instead of the joint being dried and corticated outside, made tough, leathery, and flavorless to about an inch of depth, then fairly cooked an inch further, and finally left raw, disgusting, and bloody in the middle, as it is in the orthodox roasting by British cooks, the whole is uniformly cooked throughout without the soddening action of mere boiling or steaming, as the excess of moisture is removed by the final current of hot dry air thrown in by the blow-pipes, which at the same time give the whole surface an uniform browning that can be regulated at will without burning any portion or wasting the external fat.

Rumford's second rule, that air be admitted only from below, and be limited to the requirements, is so simple that no comment upon it is needed. Although we have done so little in the improvement of domestic fireplaces, great progress has been made in engine furnaces, blast furnaces, and all other fireplaces for engineering and manufacturing purposes. Every furnace engineer now fully appreciates Rumford's assertion that excess of cold air is a thief.

The third rule is one which, as I have already stated, stands seriously in the way of any commercial "pushing" of Rumford's kitchen ranges. Those which he figures and describes are all of them masonic structures, not ironmongery; the builder must erect them, they cannot be bought ready-made; but, now that public attention is roused, I believe that any builder who will study Rumford's plans and drawings, which are very practically made, may do good service to himself and his customers by fitting up a few houses with true Rumford kitcheners, and offering to reconstruct existing kitchen ranges, especially in large houses.

The fourth rule is one that is sorely violated in the majority of kitcheners, and without any good reason. The heat from the fire of any kitchener, whether it be of brick or iron, should first do the work demanding the highest temperature, viz., roasting and baking, then proceed to the boiler or boilers, and after this be used for supplying the bed-rooms and bath-room, and the housemaid, etc., with hot water for general use, as Rumford did in his house at Brompton Row, where his chimney terminated in metal pipes that passed through a water-tank at the top of the house.

Linen-closets may also be warmed by this residual heat.

The fifth rule is also violated to an extent that renders the words uttered by Rumford nearly a century ago as applicable now as then. He said, "Nothing is so ill-judged as most of those attempts that are frequently made by ignorant projectors *to force the same fire to perform different services at the same time.*"

Note the last words, "same time." In the uses above mentioned the heat does different work successively, which is quite different from the common practice of having flues to turn the flame of one fire in opposite directions, to split its heat and make one fireplace appear to do the work of two.

Every householder knows that the kitchen fire, whether it be an old-fashioned open fireplace, or a modern kitchener of any improved construction, is a very costly affair. He knows that its wasteful work produces the chief item of his coal bill, but somehow or other he is helpless under its infliction. If he has given any special attention to the subject he has probably tried three or four different kinds without finding any notable relief. Why is this? I venture to make a reply that will cover 90 per cent, or probably 99 per cent of these cases, viz., that he has never considered the main source of waste, which Rumford so clearly defines as above, and which was eliminated in all the kitchens that he erected.

Let us suppose the case of a household of ten persons, but which in the ordinary course of English hospitality *sometimes* entertains twice that number. What do we find in the kitchen arrangements? Simply that there is one fireplace suited for the maximum requirements, *i.e.*, sufficient for twenty, even though that number may not be entertained more than half a dozen times in the course of a year. To cook a few rashers of bacon, boil a few eggs, and boil a kettle of water for breakfast, a fire sufficient to cook for a dinner party of twenty is at work. This is kept on all day long, because it is just possible that the master of the house may require a glass of grog at bedtime. There may be dampers and other devices for regulating this fire, but such regulation, even if applied, does very little so long as the capacity of the grate remains, and as a matter of ordinary fact the dampers and other regulating devices are neglected altogether; the kitchen fire is blazing and roaring to waste from 6 or 7 A. M. to about midnight, in order to do about three hours and a half work, *i.e.*, the dinner for ten, and a nominal trifle for the other meals.

In Rumford's kitchens, such as those he built for the Baron de Lerchenfeld and for the House of Industry at Munich, the kitchener is a solid block of masonry of work-bench height at top, and with a deep bay in the middle, wherein the cook stands surrounded by his boilers, steamers, roasters, ovens, etc., all within easy reach, each one supplied by its own separate fire of very small dimensions, and carefully closed with non-conducting doors. Each fire is lighted when required, charged with only the quantity of fuel necessary for the work to be done, and then extinguished or allowed to die out.

It is true that Rumford used wood, which is more easily managed in this way than coal. If we worked as he did, we might use wood likewise, and in spite of its very much higher price do our cooking at half its present cost. This would effect not merely "smoke abatement" but "smoke extinction" so far as cooking is concerned. But the lighting of fires is no longer a troublesome and costly process as in the days of halfpenny bundles of firewood. To say nothing of the improved fire-lighters, we have gas everywhere, and nothing is easier than to fix or place a suitable Bunsen or solid flame burner under each of the fireplaces (an iron gaspipe, perforated *below* to avoid clogging, will do), and in two or three minutes the coals are in full blaze; then the gas may be turned off. The writer has used such an arrangement in his study for some years past, and starts his fire in full blaze in three minutes quite independent of all female interference.

I have no doubt that ultimately gas will altogether supersede coal for cooking; but this and all other scientific improvements in domestic comfort and economy must be impossible with the present generation of uneducated domestics, whose brains (with few exceptions) have become torpid and wooden from lack of systematic exercise during their period of growth.

THE "CONSUMPTION OF SMOKE."

A GREAT deal has been spoken and written on this subject, but practically nothing has been *done*. At one time I shared the general belief in its possibility, and accordingly examined a multitude of devices for smoke-consuming, and tried several of the most promising, chiefly in furnaces for metallurgical work, for steam boilers and stills. None of them proved satisfactory, and I was driven to the conclusion that smoke-consumption is a delusion, and further, that *economical* consumption of smoke is practically impossible. When smoke is once formed, the cost of burning it far exceeds the value of the heat that is produced by the combustion of its very flimsy flocculi of carbon. It is a fiend that once raised cannot be exorcised, a Frankenstein that haunts its maker, and will not be appeased.

To describe in detail the many ingenious devices that have been proposed and expensively patented and advertised for this object, would carry me far beyond the intended limits of this paper. I must not even attempt this for a selected few, as even among them there is none that can be pronounced satisfactory.

The common idea is that if the smoke be carried back to the fire that produced it, and made to pass through it again, a recombustion or consumption of the smoke will take place. This is a mistake, as a little reflection will show. First, let us ask why did this particular fire produce such smoke? Everybody now-a-days can answer this question, as we all know that smoke is a result of imperfect combustion, and, knowing this, it can easily be understood that to return the carbonic acid and excess of carbon to the already suffocated fire can only add smother to smotheration, and make the smoky fire more smoky still.

There is, however, one case in which a fire *appears* to thus consume its own smoke, but the appearance is delusive. I refer to fires lighted from above. These, if properly managed, are practically smokeless, and it is commonly supposed that smoke passes from the raw coal below through the burning coal above, and is thereby consumed. The fact is, however, that no such smoke is formed. That which under these conditions comes from the coal beneath, when gradually heated by the fire above, is combustible *gas*, and this gas is burned as it passes through the fire. In this case the formation or non-formation of smoke depends mainly on how this gas is burned, whethey completely or incompletely. If the air supplied for its combustion is insufficient, smoke will be formed as it is when we turn up an Argand gas-flame so high that the gas is too great in proportion to the quantity of air that can enter the glass chimney.

Herein lies the fundamental principle. We may *prevent* smoke, though we cannot *cure* it, and this prevention depends upon how we supply air to the gas which the coal gives off when heated, and upon the condition of this gas when we bring it in contact with the air by which its combustion is to be effected. We must always remember that coal when its temperature is sufficiently heated, whether in a gas retort or fireplace, gives off a series of combustible hydrocarbon gases and vapors, and all we have to do in order to obtain smokeless fires is to secure the complete combustion of these.

Now we know that to burn a given quantity of gas we must supply it with a sufficient quantity of oxygen, *i.e.*, of the active principle of the air; but this is not all: we all know well enough that if cold coal-gas and cold air be brought together in any proportion whatever no combustion occurs. A certain amount of heat is necessary to start the chemical combination of oxygen with hydrogen and carbon, which combination is the combustion, or burning.

Therefore, when the coal gas and the air are brought together one or the other, or both, must be heated up to a certain point in order that the combustion be complete. If cold there is no combustion; if insufficiently heated, there is imperfect combustion, however well the supplies may be regulated.

A very simple experiment that anybody may make illustrates this. When an ordinary open fire is burning brightly and clearly without flame, throw a few small pieces of raw coal into the midst of the glowing coals. They will flame fiercely, but without smoking. Then throw a heap of coal or one large lump on a similar fire. Now you will have dense volumes of smoke, and little or no flame, simply because the cooling action of the large bulk of coal in the course of distillation brings the temperature of its gases below that required for their complete combustion.

This simple experiment supplies a most important practical lesson, as well as a philosophical example. The best of all smoke-abatement machines is an intelligent and conscientious stoker, and every contrivance for smoke abatement must, in order to be efficient, either be fed by such a stoker or provided with some automatic arrangement by which the apparatus itself does the work of such a stoker by supplying the fresh fuel just when and where it is wanted.

Cornish experience is very instructive in this respect. The engines that pump the water from the mines do a definitely measurable amount of work, and are made to register this. The stoker is a skilled workman, and prizes are given to those who obtain the largest amount of "duty" from given engines per ton of coal consumed. Instead of pitching his coal in anyhow, cramming his fire-hole, and then sitting down to sleep or smoke in company with his chimney, the Cornish, or other good fireman, feeds little and often, and deftly sprinkles the contents of his shovel just where the fire is the brightest and the hottest, and the bars are the least thickly covered. The result is remarkable. A colliery proprietor of South Staffordshire was visiting Cornwall, and went with a friend to see his works. On approaching the engine-house and seeing a whitewashed shaft with no smoke issuing from its mouth, he expressed his disappointment at finding that the engine was not at work. To all who have been accustomed to the "Black Country," where coal is so shamefully wasted because it is cheap, the tall clean whitewashed shafts of Cornwall, all so smokeless, present quite an astonishing appearance.

This is not a result of "smoke-consuming" apparatus, but mainly of careful firing. It was in the first place promoted by the high price of coal due to the cost of carriage before the Cornish railways were constructed, and it brought about a curious result. Horse-power for horse-power the cost of fuel for working Cornish pumping engines has been brought below that of pumping engines in the places where the price of coal per ton was less than one-half. Another coal famine that should raise the price of coal in London to 60*s*. per ton, and keep it there for two or three years, would effect more smoke abatement than we can hope to result from the present and many future South Kensington efforts. I need scarcely dwell upon the necessity for a due supply of air. This is well understood by everybody. An over supply of air does mischief, by carrying away wastefully a proportionate quantity of heat. The waste due to this is sometimes very serious.

After reviewing all that has been done, the conclusion that London cannot become a clean, smokeless, and beautiful city, so long as we are dependent upon open fire-grates of anything like ordinary construction, and fed with bituminous coal, is inevitable. The general use of anthracite would effect the desired change, but there is no hope of its becoming general without legislative compulsion, and Englishmen will not submit to this.

One of the most hopeful schemes is that which was propounded a short time since by Mr. Scott Moncrieff. Instead of receiving our coal in its crude state he proposes that we should have its smoke-producing constituents removed before it is delivered to us; that it should be made into a sort of artificial semi-anthracite at the gas-works by a process of half distillation, which would take away not *all* the flaming gas as at present, but that portion which is by far the richest to the gas-maker and the most unmanageable in common fires. We should thus have a material which, instead of being so difficult to light as coke and anthracite, would light more easily than crude coal, and at the same time our gas would have far greater illuminating power, as it would all be drawn off during the early period of distillation, when it is at its richest. From a given quality of coal the difference would be as twenty-four candles to sixteen. The ammonia which we now throw into the air, the naphtha and coal-tar products, which we waste, are so valuable that they would pay all the expenses at the gas-works and leave a handsome profit. We should thus get gas so much better that two burners would do the work now obtained from three. We should get all we require for lighting purposes and plenty more for heating; the intermediate profits of the coal merchant would be abolished, and our solid fuel of far better quality could be supplied twenty or thirty per cent cheaper than at present, provided always that the gas monopoly were abolished, "a consummation most devoutly to be wished for."

Mr. Moncrieff (who brought forward his scheme without any company-mongering, or claims for patent rights) estimates the saving to London at £2,125,000 per annum, over and above the far greater saving that would result from the abolition of smoke.

In connection with this scheme I may mention a fact that has not been hitherto noted, viz., that we have perforce and unconsciously done a little in this direction already. Formerly London was supplied almost exclusively with "Wallsend" and other sea-borne coals of a highly bituminous composition—soft coals that fused in the grate and caked together. Partly owing to exhaustion of the seams, and partly to the competition of railway transit, we now obtain a large proportion of hard coal from the Midlands. This is less smoky and less sooty, and hence the Metropolitan smoke nuisance has not increased quite as greatly as the population.

But I will now conclude by repeating that whatever scheme be chosen, "smoke abatement" is to be achieved, *not by smoke-consumption, but by smoke-prevention.*

THE AIR OF STOVE-HEATED ROOMS.

Whatever opinions may be formed of the merits of the exhibits at South Kensington, one result is unquestionable —the exhibition itself has done much in directing public attention to the very important subject of economizing fuel and the diminution of smoke. We sorely need some lessons. Our national progress in this direction has been simply contemptible, so far as domestic fireplaces are concerned.

To prove this we need only turn back to the essays of Benjamin Thompson, Count of Rumford, published in London just eighty years ago, and find therein nearly all that the Smoke Abatement Exhibition *ought* to teach us, both in theory and practice—lessons which all our progress since 1802, plus the best exhibits at South Kensington, we have yet to learn.

This small progress in domestic heating is the more remarkable when contrasted with the great strides we have made in the construction and working of engineering and metallurgical furnaces, the most important of which is displayed in the Siemens regenerative furnace. A climax to this contrast is afforded by a speech made by Dr. Siemens himself, in which he defends our domestic barbarisms with all the conservative inconvincibility of a born and bred Englishman, in spite of his German nationality.

The speech to which I refer is reported in the "Journal of the Society of Arts," December 9, 1881, and contains some curious fallacies, probably due to its extemporaneous character; but as they have been quoted and adopted not only in political and literary journals, but also by a magazine of such high scientific standing as *Nature* (see editorial article January 5, 1882, p. 219), they are likely to mislead many.

Having already, in my "History of Modern Invention, etc.," and in other places, expressed my great respect for Dr. Siemens and his benefactions to British industry, the spirit in which the following plain-spoken criticism is made will not, I hope, be misunderstood either by the readers of "Knowledge" or by Dr. Siemens himself.

I may further add that I am animated by a deadly hatred of our barbarous practice of wasting precious coal by burning it in iron fire-baskets half buried in holes within brick walls, and under shafts that carry 80 or 90 per cent of its heat to the clouds; that pollute the atmosphere of our towns, and make all their architecture hideous; that render scientific and efficient ventilation of our houses impossible; that promote rheumatism, neuralgia, chilblains, pulmonary diseases, bronchitis, and all the other "ills that flesh is heir to" when roasted on one side and cold-blasted on the other; that I am so rabid on this subject, that if Dr. Siemens, Sir F. Bramwell, and all others who defend this English abomination, were giant windmills in full rotation, I would emulate the valor of my chivalric predecessor, whatever might be the personal consequences.

Dr. Siemens stated that the open fireplace "communicates absolutely no heat to the air of the room, because air, being a perfectly transparent medium, the rays of heat pass clean through it."

Here is an initial mistake. It is true that air which has been artificially deprived of *all* its aqueous vapor is thus completely permeable by heat rays, but such is far from being the case with the water it contains. This absorbs a notable amount even of bright solar rays, and a far greater proportion of the heat rays from a comparatively obscure source, such as the red-hot coals and flame of a common fire. Tyndall has proved that 8 to 10 per cent of all the heat radiating from such a source as a common fire is absorbed in passing through only 5 feet of air in its ordinary condition, the variation depending upon its degree of saturation with aqueous vapor.

Starting with the erroneous assumption that the rays of heat pass "clean through" the air of the room, Dr. Siemens went on to say that the open fireplace "gives heat only by heating the walls, ceiling, and furniture, and here is the great advantage of the open fire;" and, further, that "if the air in the room were hotter than the walls, condensation would take place on them, and mildew and fermentation of various kinds would be engendered; whereas, if the air were cooler than the walls, the latter must be absolutely dry."

Upon these assumptions, Dr. Siemens condemns steam-pipes and stoves, hot-air pipes, and all other methods of directly heating the *air* of apartments, and thereby making it warmer than were the walls, the ceiling, and furniture when the process of warming commenced. It is quite true that stoves, stove-pipes, hot-air pipes, steam-pipes, etc., do this; they raise the temperature of the air directly by *convection, i.e.*, by warming the film of air in contact with their surfaces, which film, thus heated and expanded, rises towards the ceiling, and, on its way, warms the air around it, and then is followed by other similarly-heated ascending films. When we make a hole in the wall, and burn our coals within such cavity, this convection proceeds up the chimney in company with the smoke.

But is Dr. Siemens right in saying that the air of a room, raised by convection above its original temperature, and above that of the walls, deposits any of its moisture on these walls? I have no hesitation in saying very positively that he is clearly and demonstrably wrong; that no such condensation can possibly take place under the circumstances.

Suppose, for illustration sake, that we start with a room of which the air and walls are at the freezing point, 32° F., before artificial heating (any other temperature will do), and, to give Dr. Siemens every advantage, we will further suppose that the air is fully saturated with aqueous vapor, *i.e.*, just in the condition at which some of its water might be condensed. Such condensation, however, can only take place by cooling the air *below* 32°, and unless the walls or ceiling or furniture are capable of doing this they cannot receive any moisture due to such condensation, or, in other words, they must fall below 32° in order to obtain it by cooling the film in contact with them. Of course Dr. Siemens will not assert that the stoves or steam-pipes (enclosing the steam, of course), or the hot-air or hot-water pipes, will lower the *absolute* temperature of the walls by heating the air in the room.

But if the air is heated more rapidly than are the walls, etc., the *relative* temperature of these will be lower. Will condensation of moisture *then* follow, as Dr. Siemens affirms? Let us suppose that the air of the room is raised from 30° to 50° *by convection purely;* reference to tables based on the researches of Regnault, shows that at 32° the quantity of vapor required to saturate the air is sufficient to support a column of 0·182 inch of mercury, while at 50° it amounts to 0·361, or nearly double. Thus the air, instead of being in a condition of giving away its moisture to the walls, has become thirsty, or in a condition to *take moisture away from them* if they are at all damp. This is the case whether the walls remain at 32° or are raised to any higher temperature short of that of the air.

Thus the action of close stoves and of hot surfaces or pipes of any kind is exactly the opposite of that attributed to them by Dr. Siemens. They dry the air, they dry the walls, they dry the ceiling, they dry the furniture and everything else in the house.

In *our* climate, especially in the infamous jerry-built houses of suburban London, this is a great advantage. Dr. Siemens states his American experience, and denounces such heating by convection because the close stoves *there* made him uncomfortable. This was due to the fact that the winter atmosphere of the United States is very dry, even when at zero. But air, when raised from 0° to 60°, acquires about twelve times its original capacity for water. The air thus simply heated is desiccated, and it desiccates everything in contact with it, especially the human body. The lank and shriveled aspect of the typical Yankee is, I believe, due to this. He is a desiccated Englishman, and we should all grow like him if our climate were as dry as his.* The great fires that devastate the cities of the United States appear to me to be due to this general desiccation of all building materials, rendering them readily inflammable and the flames difficult of extinction.

When an undesiccated Englishman, or a German endowed with a wholesome John Bull rotundity, is exposed to this superdried air, he is subjected to an amount of bodily evaporation that must be perceptible and unpleasant. The disagreeable sensation experienced by Dr. Siemens in the stove-heated railway cars, etc., were probably due to this.

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* In each of my three visits to America I lost about thirty pounds in weight, which I recovered within a few months of my return to the "home country" (of English-speaking nations).—RICHARD A. PROCTOR.

An English house, enveloped in a foggy atmosphere, and encased in damp surroundings, especially requires stove-heating, and the most inveterate worshipers of our national domestic fetish, the open grate, invariably prefer a stove or hot-pipe-heated room, when they are unconscious of the source of heat, and their prejudice hoodwinked. I have observed this continually, and have often been amused at the inconsistency thus displayed. For example, one evening I had a warm contest with a lady, who repeated the usual praises of a cheerful blaze, etc., etc. On calling afterwards, on a bitter snowy morning, I found her and her daughters sitting at work in the billiard-room, and asked them why. "Because it is so warm and comfortable." This room was heated by an eight-inch steam-pipe, running around and under the table, to prevent the undue cooling of the indiarubber cushions, and thus the room was warmed from the middle, and equally and moderately throughout. The large reception-room, with blazing fire, was scorching on one side, and freezing on the other, at that time in the morning.

The permeability of ill-constructed iron stoves to poisonous carbonic oxide, which riddles through red-hot iron, is a real evil, but easily obviated by proper lining, The frizzling of particles of organic matter, of which we hear so much, is—if it really does occur—highly advantageous, seeing that it must destroy organic poison-germs.

Under some conditions, the warm air of a room *does* deposit moisture on its cooler walls. This happens in churches, concert-rooms, etc., when they are but occasionally used in winter time, and mainly warmed by animal heat, by congregational emanations of breath-vapor, and perspiration—*i.e.*, with warm air supersaturated with vapor. Also, when we have a sudden change from dry, frosty weather to warm and humid. Then our walls may be streaming with condensed water. Such cases were probably in the mind of Dr.

Siemens when he spoke; but they are quite different from stove-heating or pipe-heating, which increase the vapor capacity of the heated air, without supplying the demand it creates.

VENTILATION BY OPEN FIREPLACES.

THE most stubborn of all errors are those which have been acquired by a sort of inheritance, which have passed dogmatically from father to son, or, still worse, from mother to daughter. They may become superstitions without any theological character. The idea that the weather changes with the moon, that wind "keeps off the rain," are physical superstitions in all cases where they are blindly accepted and promulgated without any examination of evidence.

The idea that our open fireplaces are necessary for ventilation is one of these physical superstitions, which is producing an incalculable amount of physical mischief throughout Britain. A little rational reflection on the natural and necessary movements of our household atmospheres demonstrates at once that this dogma is not only baseless, but actually expresses the opposite of the truth. I think I shall be able to show in what follows, 1st, that they do no useful ventilation; and, 2d, that they render systematic and really effective ventilation practically impossible.

Everybody knows that when air is heated it expands largely, becomes lighter, bulk for bulk, than other air of lower temperature; and therefore, if two portions of air of unequal temperatures, and free to move, are in contact with each other, the colder will flow under the warmer, and push it upwards. The latter postulate must be kept distinctly in view, for the rising of warm air is too commonly regarded as due to some direct uprising activity or skyward affinity of its own, instead of being understood as an indirect result of gravitation. It is the downfalling of the cooler air that causes the uprising of the warmer.

Now, let us see what, in accordance with the above-stated simple laws, must happen in an ordinary English apartment that is fitted, as usual, with one or more windows more or less leaky, and one or more doors in like condition, and a hole in the wall in which coal is burning in an iron cage immediately beneath a shaft that rises to the top of the house, the fire-hole itself having an extreme height of only 24 to 30 inches above the floor, all the chimney above this height being entirely closed. (I find by measurement that 24 inches is the usual height of the upper edge of the chimney opening of an ordinary "register" stove. Old farm-house fireplaces are open to the mantlepiece.)

Now, what happens when a heap of coal is burning in this hole? Some of the heat—from 10 to 20 per cent, according to the construction of the grate—is radiated into the room, the rest is conveyed by an ascending current of air up the chimney. As this ascending current is rendered visible by the smoke entangled with it, no further demonstration of its existence is needed.

But how is it pushed up the chimney? Evidently by cooler air, that flows into the room from somewhere, and which cooler air must get under it in order to lift it. In ordinary rooms this supply of air is entirely dependent upon their defective construction—bad joinery; it enters only by the crevices surrounding the ill-fitting windows and doors, no specially designed opening being made for it. Usually the chief inlet is the space under the door, through which pours a rivulet of cold air, that spreads out as a lake upon the floor. This may easily be proved by holding a lighted taper in front of the bottom door-chink when the window and other door—if any—are closed, and the fire is burning briskly. At the same time more or less of cold air is poured in at the top and the side spaces of the door and through the window-chinks. The proportion of air entering by these depends upon the capacity of the bottom door-chink. If this is large enough it will do nearly all the work, otherwise every other possible leakage, including the key-hole, contributes.

But what is the path of the air which enters by these higher level openings? The answer to this is supplied at once by the fact that such air being colder than that of the room, it must fall immediately it enters. The rivulet under the door is thus supplemented by cascades pouring down from the top and sides of the door and the top and sides of the windows, all being tributaries to the lake of cold air covering the floor.

The next question to be considered is, what is the depth of this lake? In this, as in every other such accumulation of either air or water, the level of the upper surface of the lake is determined by that of its outlet. The outlet in this case is the chimney hole, through which all the overflow pours upwards; and, therefore, the surface of the flowing stratum of cold air corresponds with the upper part of the chimney hole, or of the register, where register stoves are used.

Below this level there is abundant ventilation, above it there is none. The cat that sits on the hearth-rug has an abundant supply of fresh air, and if we had tracheal breathing apertures all down the sides of our bodies, as caterpillars have, those on our lower extremities might enjoy the ventilation. If we squatted on the ground like savages something might be said for the fire-hole ventilator. But as we are addicted to sitting on chairs that raise our breathing apparatus considerably above the level of the top of the register, the maximum efficiency of the flow of cold air in the lake below is expressed by the prevalence of chilblains and rheumatism.*

The atmosphere in which our heads are immersed is practically stagnant; the radiations from the fire, plus the animal heat from our bodies, just warm it sufficiently to enable the cool entering air to push it upwards above the chimney outlet and the surface of the lower moving stratum, and to keep it there in a condition of stagnation.

If anybody doubts the correctness of this description, he has only to sit in an ordinary English room where a good fire is burning—the doors and windows closed, as usual—

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*Since the above was written, a correspondent in Paris tells me that a caricature exists, representing a Frenchman enjoying an open fire by standing on his head in the middle of the room.

and then to blow a cloud by means of pipe, cigar, or by burning brown paper or otherwise, when the movements below and the stagnation above, which I have described, will be rendered visible. If there is nobody moving about to stir the air, and the experiment is fairly made, the level of the cool lake below will be distinctly shown by the clearing away of the smoke up to the level of the top of the register opening, towards which it may be seen to sweep.

Above this the smoke-wreaths will remain merely waving about, with slight movements due to the small inequalities of temperature caused by the fraction of heat radiated into the room from the front of the fire. These movements are chiefly developed near the door and windows, where the above-mentioned cascades are falling, and against the walls and furniture, where feeble convection currents are rising, due to the radiant heat absorbed by their surfaces. The stagnation is the most complete about the middle of the room, where there is the greatest bulk of vacant air-space.

When the inlet under the door is of considerable dimensions, there may be some escape of warmer upper air at the top of the windows, if their fitting is correspondingly defective. These, however, are mere accidents; they are not a part of the vaunted chimney-hole ventilation, but interferences with it.

There is another experiment that illustrates the absence of ventilation in such rooms where gas is burning. It is that of suspending a canary in a cage near the roof. But this is cruel; it kills the bird. It would be a more satisfactory experiment to substitute for the canary-bird any wingless biped who, after reading the above, still maintains that our fire-holes are effective ventilators.

Not only are the fire-holes worthless and mischievous ventilators themselves, but they render efficient ventilation by any other means practically impossible. The "Arnott's ventilator" that we sometimes see applied to the upper part of chimneys is marred in its action by the greedy "draught" below.

The tall chimney-shaft, with a fire burning immediately below it, dominates all the atmospheric movement in the house, unless another and more powerful upcast shaft be somewhere else in communication with the apartments. But in this case the original or ordinary chimney would be converted into a dowcast shaft pouring air downwards into the room, instead of carrying it away upwards. I need not describe the sort of ventilation thus obtainable while the fire is burning and smoking.

Effective sanitary ventilation should supply gentle and uniformly-diffused currents of air of moderate and equal temperature throughout the house. We talk a great deal about the climate here and the climate there; and when we grow old, and can afford it, we move to Bournemouth, Torquay, Mentone, Nice, Algiers, etc., for better climates, forgetting all the while that the climate in which we practically live is not that out-of-doors, but the indoor climate of our dwellings, the which, in a properly constructed house, may be regulated to correspond to that of any latitude we may choose. I maintain that the very first step towards the best attainable approximation to this in our existing houses is to brick up, cement up, or otherwise completely stop up, all our existing fire-holes, and abolish all our existing fires.

But what next? The reply to this will be found in the next chapter.

DOMESTIC VENTILATION.

A Lesson from the Coal-Pits.

We require in our houses an artificial temperate climate which shall be uniform throughout, and at the same time we need a gentle movement of air that shall supply the requirements of respiration without any gusts, or draughts, or alternations of temperature. Everybody will admit that these are fundamental *desiderata*, but whoever does so becomes thereby a denouncer of open-grate fireplaces, and of every system of heating which is dependent on any kind of stoves with fuel burning in the rooms that are to be inhabited. All such devices concentrate the heat in one part of each room, and demand the admission of cold air from some other part or parts, thereby violating the primary condition of uniform temperature. The usual proceeding effects a specially outrageous violation of this, as I showed in the last chapter.

I might have added domestic cleanliness among the *desiderata;* but in the matter of fireplaces, the true-born Briton, in spite of his fastidiousness in respect to shirt-collars, etc., is a devoted worshiper of dirt. No matter how elegant his drawing-room, he must defile it with a coal-scuttle, with dirty coals, poker, shovel, and tongs, dirty ash-pit, dirty cinders, ashes, and dust, and he must amuse himself by doing the dirty work of a stoker towards his "cheerful, companionable, pokeable" open fire.

It is evident that, in order to completely fulfil the first-named requirements, we must, in winter, supply our model residence with fresh artificially-warmed air, and in summer with fresh cool air. How is this to be done? An approach to a practical solution is afforded by examining what is actually done under circumstances where the ventilation problem presents the greatest possible difficulties, and where, nevertheless, these difficulties have been effectually overcome. Such a case is presented by a deep coal mine. Here we have a little working world, inhabited by men and horses, deep in the bowels of the earth, far away from the air that must be supplied in sufficient quantities, not only to overcome the vitiation due to their own breathing, but also to sweep out the deadly gaseous emanations from the coal itself.

Imagine your dwelling-house buried a quarter of a mile of perpendicular depth below the surface of the earth, and its walls giving off suffocating and explosive gases in such quantities that steady and abundant ventilation shall be a matter of life or death, and that in spite of this it is made so far habitable that men who spend half their days there retain robust health and live to green old age, and that horses after remaining there day and night for many months actually improve in condition. Imagine, further, that the house thus ventilated has some hundreds of small, very low-roofed rooms, and a system of passages or corridors with an united length of many miles, and that its inhabitants count by hundreds.

Such dwellings being thus ventilated and rendered habitable for man and beast, it is idle to dispute the practical possibility of supplying fresh air of any given temperature to a mere box of brick or stone, standing in the midst of the atmosphere, and containing but a few passages and apartments.

The problem is solved in the coal-pit by simply and skilfully controlling and directing the natural movements of unequally-heated volumes of air. Complex mechanical devices for forcing the ventilation by means of gigantic fan-wheels, etc., or by steam-jets, have been tried, and are now generally abandoned. An inlet and an outlet are provided, *and no air is allowed to pass inwards or outwards by any other course than that which has been pre-arranged for the purposes of efficient ventilation.* I place especial emphasis on this condition, believing that its systematic violation is the primary cause of the bungling muddle of our domestic ventilation.

Let us suppose that we are going to open a coal-pit to mine the coal on a certain estate. We first ascertain the "dip" of the seam, or its deviation from horizontality, and then start at the *lowest* part, not, as some suppose, at that part nearest to the surface. The reason for this is obvious on a little reflection, for if we began at the shallowest part of an ordinary water-bearing stratum we should have to drive down under water; but, by beginning at the lowest part and driving upwards, we can at once form a "sumpf," or bottom receptacle, to receive the drainage, and from which the accumulated water may be pumped. This, however, is only by the way, and not directly connected with our main subject, the ventilation.

In order to secure this, the modern practice is to sink two pits, "a pair," as they are called, side by side, at any convenient distance from each other. If they are deep, it becomes necessary to commence ventilation of the mere shafts themselves in the course of sinking. This is done by driving an air-way—a horizontal tunnel from one to the other, and then establishing an "upcast" in one of them by simply lighting a fire there. This destroys the balance between the two communicating columns of air; the cooler column in the shaft without a fire, being heavier, falls against the lighter column, and pushes it up just as the air is pushed up one leg of an U tube when we pour water down the other. Even in this preliminary work, if the pits are so deep that more than one air-way is driven, it is necessary to stop the upper ways and leave only the lowest open, in order that the ventilation shall not take a short and useless cut, as it does up our fireplace openings.

Let us now suppose that the pair of pits are sunk down to the seam, with a further extension below to form the water sumpf. There are two chief modes of working a coal-seam: the "pillar and stall" and the "long wall," or more modern system. For present illustration, I select the latter as the simplest in respect to ventilation. This method, as ordinarily worked, consists essentially in first driving roads through the coal, from the pits to the outer boundary of the area to be worked, then cutting a cross-road that shall connect these, thereby exposing a "long wall" of coal, which, in working, is gradually cut away towards the pits, the roof remaining behind being allowed to fall in.

Let us begin to do this by driving, first of all, two main roads, one from each pit. It is evident that as we proceed in such burrowing, we shall presently find ourselves in a *cul de sac* so far away from the outer air that suffocation is threatened. This will be equally the case with both roads. Let us now drive a cross-cut from the end of each main road, and thus establish a communication from the down-cast shaft through its road, then through the drift to the upcast road and pit. But in order that the air shall take this roundabout course, we must close the direct drift that we previously made between the two shafts, or it will proceed by that shorter and easier course. Now we shall have air throughout both our main roads, and we may drive on further until we are again stopped by approximate suffocation. When this occurs, we make another cross-cut, but in order that it may act we must stop the first one. So we go on until we reach the working, and then the long wall itself becomes the cross communication, and through this working-gallery the air sweeps freely and effectually.

In the above I have only considered the simplest possible elements of the problem. The practical coal-pit in full working has a multitude of intervening passages and "splits," where the main current from the downcast is divided, in order to proceed through the various streets and lanes of the subterranean town as may be required, and these divided currents are finally reunited ere they reach the upcast shaft which casts them all out into the upper air.

In a colliery worked on the pillar and stall system—*i.e.*, by taking out the coal so as to leave a series of square chambers with pillars of coal in the middle to support the roof—the windings of the air between the multitude of passages is curiously complex, and its absolute obedience to the commands of the mining engineer proves how completely the most difficult problems of ventilation may be solved when ignorance and prejudice are not permitted to bar the progress of the practical applications of simple scientific principles.

Here the necessity of closing all false outlets is strikingly demonstrated by the mechanism and working of the "stoppings" or partitions that close all unrequired openings. The air in many pits has to travel several miles in order to get from the downcast to the upcast shaft, though they may be but a dozen yards apart. (Formerly the same shaft served both for up and down cast, by making a wooden division (a *brattice*) down the middle. This is now prohibited, on account of serious accidents that have been caused by the fracture of the *brattice*.)

But it would not do to carry the coal from the workings to the pit by these sinuous air-courses. What, then, is done? A direct road is made for the coal, but if it were left open, the air would choose it: this is prevented by an arrangement similar to that of canal locks. Valve-doors or "stoppings" are arranged in pairs, and when the "hurrier" arrives with his *corve*, or pit carriage, one door is opened, the other remaining shut; then the *corve* is hurried into the space between the doors, and the entry-door is closed; now the exit-door is opened, and thus no continuous opening is ever permitted.

Only one such opening would derange the ventilation of the whole pit, or of that portion fed by the split thus allowed to escape. It would, in fact, correspond to the action of our open fireplaces in rendering effective ventilation impossible.

The following, from the report of the Lords' Committee on Accidents in Coal Mines, 1849, illustrates the magnitude of the ventilation arrangements then at work. In the Hetton Colliery there were two downcast shafts and one upcast, the former about 12 feet and the latter 14 feet diameter. There were three furnaces at the bottom of the upcast, each about 9 feet wide with about 4 feet length of grate-bars; the depth of the upcast and one downcast 900 feet, and of the other downcast 1056 feet. The quantity of air introduced by the action of these furnaces was 168,560 cubic feet per minute, at a cost of about eight tons of coal per day. The rate of motion of the air was 1097 feet per minute (above 12 miles per hour). This whole current was divided by splitting into 16 currents of about 11,000 cubic feet each per minute, having, on an average, a course of 4¼ miles each. This distance was, however, very irregular— the greatest length of course being $9\frac{1}{10}$ miles; total length 70 miles. Thus 168,560 cubic feet of air were driven through these great distances at the rate of 12 miles per hour, and at a cost of 8 tons of coal per day.

All these magnitudes are greatly increased in coal-mines of the present time. As much as 250,000 cubic feet of air per minute are now passed through the shafts of one mine.

The problem of domestic ventilation as compared with coal-pit ventilation involves an additional requirement, that of warming, but this does not at all increase the difficulty, and I even go so far as to believe that cooling in summer may be added to warming in winter by one and the same ventilating arrangement. As I am not a builder, and claim no patent rights, the following must be regarded as a general indication, not as a working specification, of my scheme for domestic ventilation and the regulation of home climate.

The model house must have an upcast shaft, placed as nearly in the middle of the building as possible, with which every room must communicate either by a direct opening or through a lateral shaft. An ordinary chimney built in the usual manner is all that is required to form such a main shaft.

There must be no stoves nor any fireplaces in any room excepting the kitchen, of which anon. All the windows must be made to fit closely, as nearly air-tight as possible. No downcast shaft is required, the pressure of the surrounding outer atmosphere being sufficient. Outside of the house, or on the ground floor (on the north side, if possible), should be a chamber heated by flues, hot air, steam, a suitable stove, or water-pipes, and with one adjustable opening communicating with the outer fresh air, and another on the opposite side connected by a shaft or air-way with the hall of the ground floor and the general staircase.

Each room to have an opening at its upper part communicating with the chimney, like an Arnott's ventilator, and capable of adjustment as regards area of aperture, and other openings of corresponding or excessive combined area leading from the hall or staircase to the lower part of the room. These may be covered with perforated zinc or wire gauze, so that the air may enter in a gentle, broken stream.

All the outer house-doors must be double, *i.e.*, with a porch or vestibule, and only one of each pair of doors opened at once. These should be well fitted, and the staircase air-tight. The kitchen to communicate with the rest of the house by similar double doors, and the kitchen fire to communicate directly with the upcast shaft or chimney by as small a stove-pipe as practicable. The kitchen fire will thus start the upcast and commence the draught of air from the warm chamber through the house towards the several openings into the shaft. In cold weather, this upcast action will be greatly reinforced and maintained by the general warmth of all the air in the house, which itself will bodily become an upcast shaft immediately the inner temperature exceeds that of the air outside.

But the upcast of warm air can only take place by the admission of fresh air through the heating chamber, thence to hall and staircase, and thence onward through the rooms into the final shaft or chimney.

The openings into and out of the rooms being adjustable, they may be so regulated that each shall receive an equal share of fresh warm air; or, if desired, the bedroom chimney valves may be closed in the daytime, and thus the heat economized by being used only for the day rooms; or, *vice versâ,* the communication between the upcast shaft and the lower rooms may be closed in the evening, and thus all the warm air be turned into the bedrooms at bedtime.

If the area of the entrance apertures of the rooms exceeds that of the outlet, only the latter need be adjusted; the room doors may, in fact, be left wide open without any possibility of "draught," beyond the ventilation current, which is limited by the dimension of the opening from the room into the shaft or chimney.

So far, for winter time, when the ventilation problem is the easiest, because then the excess of inner warmth converts the whole house into an upcast shaft, and the whole outer atmosphere becomes a downcast. In the summer time, the kitchen fire would probably be insufficient to secure a sufficiently active upcast.

To help this there should be in one of the upper rooms —say an attic—an opening into the chimney secured by a small well-fitting door; and altogether enclosed within the chimney a small automatic slow-combustion stove (of which many were exhibited in South Kensington, that require feeding but once in twenty-four hours), or a large gas-burner. The heating-chamber below must now be converted into a cooling chamber by an arrangement of wet cloths, presently to be described, so that all the air entering the house shall be reduced in temperature.

Or the winter course of ventilation may be reversed by building a special shaft connected with the kitchen fire, which, in this case, must not communicate with the house shaft. This special shaft may thus be made an upcast, and the rooms supplied with air from above down the house shaft, through the rooms, and out of the kitchen *viâ* the winter heating-chamber, which now has its communication with the outside air closed.

Reverting to the first-named method, which I think is better than the second, besides being less expensive, I must say a few concluding words on an important supplementary advantage which is obtainable wherever all the air entering the house passes through one opening, completely under control, like that of our heating-chamber. The great evil of our town atmosphere is its dirtiness. In the winter it is polluted with soot particles; in the dry summer weather, the traffic and the wind stir up and mix with it particles of dust, having a composition that is better ignored, when we consider the quantity of horse-dung that is dried and pulverized on our roadways. All the dust that falls on our books and furniture was first suspended in the air we breathe inside our rooms. Can we get rid of any practically important portion of this?

I am able to answer this question, not merely on theoretical grounds, but as a result of practical experiments described in the following chapter, in which is reprinted a paper I read at the Society of Arts, March 19, 1879, recommending the enclosure of London back yards with a roofing of "wall canvas," or "paperhanger's canvas," so as to form cheap conservatories. This canvas, which costs about threepence per square yard, is a kind of coarse, strong, fluffy gauze, admitting light and air, but acting very effectively as an air filter, by catching and stopping the particles of soot and dust that are so fatal to urban vegetation.

I propose, therefore, that this well-tried device should be applied at the entrance aperture of our heating chamber, that the screens shall be well wetted in the summer, in order to obtain the cooling effect of evaporation, and in the winter shall be either wet or dry, as may be found desirable. The Parliament House experiments prove that they are good filters when wetted, and mine that they act similarly when dry.

By thus applying the principles of colliery ventilation to a specially-constructed house, we may, I believe, obtain a perfectly controllable indoor climate, with a range of variation not exceeding four or five degrees between the warmest and the coldest part of the house, or eight or nine degrees between summer and winter, and this may be combinbd with an abundant supply of fresh air everywhere, all filtered from the grosser portions of its irritant dust, which is positively poisonous to delicate lungs, and damaging to all. The cost of fuel would be far less than with existing arrangements, and the labor of attending to the one or two fires and the valves would also be less than that now required in the carrying of coal-scuttles, the removal of ashes, the cleaning of fireplaces, and the curtains and furniture they befoul by their escaping dust and smoke.

It is obvious that such a system of ventilation may even be applied to existing houses by mending the ill-fitting windows, shutting up the existing fire-holes, and using the chimneys as upcast shafts in the manner above described. This may be done in the winter, when the problem is easiest, and the demand for artificial climate the most urgent; but I question the possibility of summer ventilation and tempering of climate in anything short of a specially-built house or a materially altered existing dwelling. There are doubtless some exceptions to this, where the house happens to be specially suitable and easily adapted, but in ordinary houses we must be content with the ordinary devices of summer ventilation by doors and windows, plus the upper openings of the rooms into the chimneys expanded to their full capacity, and thus doing, even in summer, far better ventilating work than the existing fire-holes opening in the wrong place.

I thus expound my own scheme, not because I believe it to be perfect, but, on the contrary, as a suggestive project to be practically amended and adapted by others better able than myself to carry out the details. The feature that I think is novel and important is that of consciously and avowedly applying to domestic ventilation the principles that have been so successfully carried out in the far more difficult problem of subterranean ventilation.

The dishonesty of the majority of the modern builders of suburban "villa residences" is favorable to this and other similar radical household reforms, as thousands of these wretched tenements must sooner or later be pulled down, or will all come down together without any pulling the next time we experience one of those earthquake tremors which visit England about once in a century.

HOME GARDENS FOR SMOKY TOWNS.

THE poetical philanthropists of the shepherd and shepherdess school, if any still remain, may find abundant material for their doleful denunciations of modern civilization on journeying among the house-tops by any of our over-ground metropolitan and suburban railways, and contemplating therefrom the panorama presented by a rapid succession of London back yards. The sandy Sahara, and the saline deserts of Central Asia, are bright and breezy, rural and cheerful, compared with these foul, soot-smeared, lumber-strewn areas of desolation.

The object of this paper is to propose a remedy for these metropolitan measle-spots, by converting them into gardens that shall afford both pleasure and profit to all concerned.

A very obvious mode of doing this would be to cover them with glass, and thus convert them into winter gardens or conservatories. The cost of this at once places it beyond practical reach; but even if the cost were disregarded, as it might be in some instances, such covering in would not be permissible on sanitary grounds; for, doleful and dreary as they are, the back yards of London perform one very important and necessary function; they act as ventilation-shafts between the house-backs of the more densely populated neighborhoods.

At one time I thought of proposing the establishment of horticultural home missions for promoting the dissemination of flower-pot shrubs in the metropolis, and of showing how much the atmosphere of London would be improved if every London family had one little sweetbriar bush, a lavender plant, or a hardy heliotrope to each of its members; so that a couple of million of such ozone generators should breathe their sweetness into the dank and dead atmosphere of the denser central regions of London.

A little practical experience of the difficulty of growing a clean cabbage, or maintaining alive any sort of shrub in the midst of our soot-drizzle, satisfied me that the mission would fail, even though the sweetbriars were given away by the district visitors; for these simple hardy plants perish in a mid-London atmosphere unless their leaves are periodically sponged and syringed, to wash away the soot particles that otherwise close their stomata and suffocate the plant.

It is this deposit that stunts or destroys all our London vegetation, with the exception of those trees which, like the planes have a deciduous bark and cuticle.

Some simple and inexpensive means of protecting vegetation from London soot are, therefore, most desirable.

When the Midland Institute commenced its existence in temporary buildings in Cannon Street, Birmingham, in 1854, I was compelled to ventilate my class-rooms by temporary devices, one of which was to throw open the existing windows, and protect the students from the heavy blast of entering air by straining it through a strong gauze-like fabric stretched over the opening.

After a short time the tammy became useless for its intended purpose; its interstices were choked with a deposit of carbon. On examining this, I found that the black deposit was all on the outside, showing that a filtration of the air had occurred. Even when the tammy was replaced by perforated zinc, puttied into the window frames in the place of glass panes, it was found necessary to frequently wash the zinc, in order to keep the perforations open.

The recollection of this experience suggested that if a gauze-like fabric, cheaper and stronger than the tammy, can be obtained, and a sort of greenhouse made with this in the place of glass, the problem of converting London backyards into gardens might be solved.

After some inquiries and failures in the trial of various cheap fabrics, I found one that is already to be had, and well adapted to the purpose. It is called "wall canvas," or "scrim," is retailed at 3½*d.* per yard, and is one yard wide. If I am rightly informed, it may be bought in wholesale quantities at about 2¼*d.* per square yard, *i.e.*, one farthing per square foot. This fabric is made of coarse unbleached thread yarn, very strong and open in structure. The light passes so freely through it that when hung before a window the loss of light in the room is barely perceptible. When a piece is stretched upon a frame, a printed placard, or even a newspaper, may be read through it.

The yarn being loosely spun, fine fluffy filaments stand out and bar the interstices against the passage of even very minute carbonaceous particles. These filaments may be seen by holding it up to the light.

The fabric being one yard wide, and of any length required, all that is needed for a roof or side walls is a skeleton made of lines or runs of quartering, at 3 feet distance from each other. The cost of such quartering, made of pitch pine, the best material for outside work, is under one penny per foot run; of common white deal, about three farthings. Thus the cost of material for a roof, sa a lean-to from a wall-top to the side of a house, which would be the most commonly demanded form of 30 feet by 10 feet, *i.e.*, 300 square feet, would be—

	s.	*d.*
110 feet of quartering (11 lengths) at 1*d*.........	9	2
300 square feet of canvas, at 1¼.................	6	3 *
Nails and tacks, say..........................	1	0
	16	5

The size of the quartering proposed is 2½ by 1¼ inch, which, laid edgewise, would bear the weight of a man on a plank while nailing down the canvas. The canvas has a stout cord-like edge or selvage, that holds the nails well.

I find that what are called "French tacks" are well suited for nailing it down. They are made of wire, well pointed, have good-sized flat clout heads, and are very cheap. They are incomparably superior to the ordinary rubbish sold as "tin tacks" or "cut tacks." The construction of such a conservatory is so simple that any industrious artisan or clerk with any mechanical ingenuity could, with the aid of a boy, do it all himself. No special skill is required for any part of the work, and no other tools than a rule, a saw, and a hammer. Side posts and stronger end rails would in some cases be demanded.

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* See foot-note, page 365.

I have not been able to fairly carry out this project, inasmuch as I reside at Twickenham, beyond the reach of the black showers of London soot. I have, however, made some investigations relative to the climate which results from such enclosure.

This was done by covering a small skeleton frame with the canvas, putting it upon the ground over some cabbage plants, etc., and placing registering thermometers on the ground inside, and in similar position outside the frame; also by removing the glass cover of a cucumber frame, and replacing it by a frame on which the canvas is stretched.

I planted 300 cabbages in November last, in rows on the open ground, and placed the canvas-covered frame over 18 of them. At the present date, March 15, only 26 of the 282 outside plants are visible above the ground. All the rest have been cut off by the severe frost. Under the frame *all* are flourishing.

I find that the difference between the maximum and the minimum temperatures varies with the condition of the sky. In cloudy weather, the difference between the inside and the outside rarely exceeds 2° Fahr., and occasionally there is no difference. In clear weather the difference is considerable. During the day the outside thermometer registers from four or five to seven or eight degrees above that within the screen during the sunshine. At night the minimum thermometers show a difference which in one case reached 14°, *i.e.*, between 23d and 24th February, when the lowest temperature I have observed was reached. The outside thermometer then fell to 8° Fahr., the inside to 22°. On the night of the 24th and 25th they registered 15½° outside, 25½° inside. On other, or ordinary clear frosty nights, with E. and N. and N.E. winds, the difference has ranged between 4° and 6°, usually within a fraction of the average, 5°.

The uniformity of this during the recent bright frosty nights, followed by warm sunny days, has been very remarkable, so much so that I think I may venture to state that 5° may be expected as the general protecting effect of a covering of such canvas from the mischievous action of our spring frosts which are due to nocturnal radiation into free space. Thus we obtain a climate, the mean of which would be about the same as outside, but subject to far less variation. How will this affect the growth of plants desirable to cultivate in the proposed canvas conservatories?

In the first place, we must not expect the results obtainable under glass, which by freely transmitting the bright solar rays, and absorbing or resisting the passage of the obscure rays from the heated soil, produces, during sunshine, a tropical climate here in our latitudes. We may therefore at once set aside any expectation of rearing exotic plants of any kind; even our native and acclimatized plants, which require the maximum heat of English sunshine, are not likely to flourish.

On the other hand, all those which demand moderate protection from sudden frosts, especially from spring frosts, and which flourish when we have a long mild spring and summer, are likely to be reared with especial success.

This includes nearly all our table vegetables, our salads, kitchen herbs, and British fruits, all our British and many exotic ferns, and, I believe, most of our out-of-door plants, both wild and cultivated.

As the subject of ornamental flowers is a very large one, and one with the cultivation of which I have very little practical acquaintance, I will pass it over; but must simply indicate that, in respect to ferns, the canvas enclosure offers a combination of most desirable conditions. The slight shade, the comparatively uniform temperature, and the moderated exhalation, are just those of a luxuriant fern dingle.

Respecting the useful or economic products I can speak with more confidence, that being my special department in our family or home gardening, which, as physical discipline, I have always conducted myself, with a minimum of professional aid.

My experience of a small garden leads me to give first place to salads. A yard square of rich soil, well managed, will yield a handsome and delicious weekly dish of salad nearly all the year round; and, at the same rate, seven or eight square yards will supply a daily dish—including lettuces, endives, radishes, spring onions, mustard, and various kinds of cress, and fancy salads, all in a state of freshness otherwise unattainable by the Londoner. My only difficulty has arisen from irregularity of supply. From the small area allowed for salads, I have been over-supplied in July, August, and September, and reduced to in-door or frame-grown mustard and cress during the winter. With the equable insular climate obtainable under the canvas, this difficulty will be greatly diminished; and besides this, most of the salads are improved by partial shade, lettuces and endives more blanched and delicate than when exposed to scorching sun, radishes less fibrous, mustard, cress, etc., milder in flavor and more succulent.

The multitude of savory kitchen herbs that are so sadly neglected in English cookery (especially in the food of the town artisan and clerk), all, with scarcely an exception, demand an equable climate and protection from our destructive spring frosts. These occupy very little space, less even than salads, and are wanted in such small quantities at a time, and so frequently, that the hard-worked housewife commonly neglects them altogether, rather than fetch them from the greengrocer's in their exorbitantly small pennyworths. If she could step into the back yard, and gather her parsley, sage, thyme, winter savory, mint, marjoram, bay leaf, rosemary, etc., the dinner would become far more savory, and the demand for the alcoholic substitutes for relishing food proportionably diminished.

My strongest anticipations, however, lie in the direction of common fruits—apples, pears, cherries, plums of all kinds, peaches, nectarines, gooseberries, currants, raspberries, strawberries, etc.

The most luxuriant growth of cherries, currants, gooseberries, and raspberries I have ever seen in any part of the world that I have visited, is where they might be least expected, viz., Norway; not the South of Norway merely, but more particularly in the valleys that slope from the 500 square miles of the perpetual ice desert of the Justedal down to the Sognefjord, latitude 61° to 61½°, considerably to the north of the northernmost of the Shetland Islands. The cherry and currant trees are marvelous there.

In the garden of one of the farm stations (Sande) I counted 70 fine bunches of red currants growing on six inches of one of the overladen down-hanging stems of a currant bush. Cherries are served for dessert by simply breaking off a small branch of the tree and bringing it to the table—the fruit almost as many as the leaves.

This luxuriance I attribute to two causes. First, that in that part of Norway the winter breaks up suddenly at about the beginning of June, and not until then, when night frosts are no longer possible, do the blossoms appear. It was on the 24th August that I counted the 70 bunches of ripe currants. The second cause is the absence of sparrows and other destructive small birds that devour our currants for the seeds' sake before they ripen, and our cherries immediately on ripening. These are preceded by the bullfinches that feed on the tender hearts of the buds of most of our fruit trees. Those who believe the newspaper myths which represent such thick-billed birds eating caterpillars, should make observations and experiments for themselves as I have done.

In our canvas conservatories neither sparrows nor caterpillars, nor wasps, or other fruit-stealers will penetrate, nor will the spring frosts nip the blossoms that open out in April. All the conditions for full bearing are there fulfilled, and the ripening season, though not so intense, will be prolonged. We shall have an insular Jersey climate in London, where the mean temperature is higher than in the country around, and, if I am not quite deluded, we shall be able to grow the choicest Jersey pears, those that best ripen by hanging on the tree until the end of December, and fine peaches, which are commonly destroyed by putting forth their blossoms so early. All the hundred and one varieties of plums and damsons, greengages, etc., that can grow in temperate climates will be similarly protected from the frosts that kill their early blossoms, and the birds and the wasps that will not give them time to ripen slowly.

I have little doubt that if my project is carried out, any London householder, whether rich or poor, may indulge in delicious desserts of rich fruit all grown on the sites of their own now dirty and desolate back-yards; that if prizes be given for the most prolific branches of cherry and plum trees, gooseberry and currant bushes, the gardens of the Seven-dials and of classic St. Giles's may carry off some of the gold medals; and that, by judicious economy of space and proper pruning of the trees, the canvas conservatories may be made not only to serve as orchard houses, but also to grow the salads, kitchen herbs, and green vegetables for cookery, under the fruit trees or close around their stems.

Among the suitable vegetables, I may name a sort of perennial spinach which yields a wonderful amount of produce on a small area. Four years ago I took the house in which I now reside, and found the garden overgrown with a weed that appeared like beet, the leaves being much larger than ordinary spinach. I tried in vain to eradicate it, then gave some leaves to my fowls. They ate them greedily. After this I had some boiled, and found that the supposed weed is an excellent spinach, which may be sown broadcast in thick patches, without any interspaces, and cut down again and again all the year round, fresh leaves springing up from the roots until the autumn, when it throws up tall flowering stems, and yields an abundant crop of seeds. I have some now, self-sown, that have survived the whole of the late severe winter, while turnip-tops, cabbages, and everything else have perished. I have sown the ordinary spinach seed in the usual manner in rows, and comparing it with the self-sown dense patches of this intruder, find the latter produces, square yard against square yard, six or eight times as much of available eatable crop.

None of my friends who are amateur gardeners know this variety; but a few days since, I called on Messrs. James Carter and Co., the wholesale seedsmen of Holborn, and described it. They gave me a packet of what they call "Perpetual spinach beet," which, as may be seen by comparison with the seeds of those I have here of my own growing, is probably the same. Messrs. Carter and Co. tell me that the plant is very little known, and the seed scarce from want of cultivation and demand. I therefore step so far aside to describe and recommend it as specially suited for obtaining large crops on small areas.*

I also recommend a mode of growing cabbages that I have found very profitable, viz., to sow the seed broadcast in richly manured beds or patches and leave the plants crowding together; cut them down while very young, without destroying the centre bud; let them sprout again and again. They thus yield a succession of crops, every leaf of which is eatable. This, instead of transplanting and growing large plants, which, however desirable for sale in the market, are far less profitable for home use. Celery may be grown in like manner, and cut down young and green for boiling.

Some collateral advantages may de fairly anticipated in cases where the back-yard is fully enclosed by the canvas.

In the first place, the air coming into the house from the back will be more or less filtered from the grimy irritant particles with which our London atmosphere is loaded, besides obtaining the oxygen given off by the growing plants, and the ozone which recent investigations have shown to be produced where aromatic plants—such as kitchen herbs—are growing. Lavender, which is very hardy, and spreads spontaneously, might be grown for this purpose.

Back-doors might be left open for ventilation, without danger of intrusion or of slamming by gusts of wind. The air thus admitted would be tempered both in summer and winter. By wetting the canvas, which may easily be done by means of a small garden engine, or hand syringe, the exceptionally hot summer days that are so severely felt in London might be moderated to a considerable extent. The air under the canvas being cooler than that in front would enter from below, while the warmer air would be pushed upwards and outwards to the front.

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*I tried the seeds given to me by Messrs. Carter, and find them to produce the same plant as my own, which I still cultivate very successfully. I now sow it in the spring as a kitchen garden border.

Although such conservatories may be erected, as already stated, by artisans or other tenants of small houses, I do not advocate dependence on this; but, on the contrary, regard them as more properly constituting landlord's fixtures, and recommend their erection by owners of small house property in London and other large towns. A workman who will pay a trifle extra for such a garden, is likely to be a better and more permanent tenant than one who is content with the slovenly squallor of ordinary back premises.

I base this opinion on some experience of holding small houses in the outskirts of Birmingham (Talbot Street, Winson Green.) These have small gardens, while most of those around have none. They are held by weekly tenure, and, during eighteen years, I have not lost a week's rent from voids; the men who would otherwise shift their dwelling when they change workshops, prefer to remain and walk some distance rather than lose their little garden crops; and when obliged to leave, have usually found me another tenant, a friend who has paid them a small tenant-right premium for what is left in the garden, or for the privilege of getting a house with such a garden.

A small garden is one of the best rivals to the fascinations of the tap-room; the strongest argument in favor of my canvas conservatories, and that which I reserve as the last, is that they are likely to become the poor man's drawing-room, where he may spend his summer evenings, smoke his pipe, contemplate his growing plants, and show them in rivalry to his friends, rather than slink away from an unattractive home to seek the sensual excitements that ruin so many of our industrious fellow-countrymen.

As above stated, I have not been able practically to test the filtering capabilities of the canvas, owing to my residence out of town, but since the above was written, *i.e.*, on last Wednesday evening, I visited the Houses of Parliament, where, as I had been told, the ventilation arrangements include some devices for filteriag the air by cotton, wool or otherwise.

I was much interested on finding that the long experience and many trials of Dr. Percy and his assistant engineer, Mr. Prim, have resulted in the selection of the identical material which I have chosen, and with which the above-described experiments have been made. A wall of such canvas surrounds a lower region of the Houses, and all the air that is destined to have the privilege of being breathed by British legislators is passed through this vertical screen, for the purpose of separating from it the sooty impurities that constitute the special abomination of our metropolitan atmosphere, and that of our great manufacturing towns. The quantity of sooty matter thus arrested is shown by the fact that it is found necessary to take the screens down once a week and wash them, the wash water coming away in a semi-inky condition.

I anticipate that the conservatory filters will rapidly clog, and, therefore, require washing. This may easily be done by means of a jet from a hand-syringe directed from within outwards, especially if the slope of the roof is considerable, which is to be recommended. The filtering screen of the Houses of Parliament is made by sewing the canvas edges together, to form a large continuous area, then edging the borders of this with tape, and stretching it bodily on to a stout frame. This method may be found preferable to that which I proposed above, and cheaper than I have estimated, as only very light intermediate cross-pieces would thus be required, merely to prevent bagging, the parliamentary quartering above described being nine feet apart instead of three. This would reduce the cost of timber to about one half of the above estimate.* The perpendicular walls of a conservatory, where such are required, may certainly be made thus, and I think the roof also, if the slope is considerable. Or, if in demand, the material may be made of greater width than the three feet.

So far, I have only mentioned back-yards; but, besides these, there are many very melancholy front areas, called

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* Subsequent experiments induce me not to recommend this economy, on account of the bagging which results from excessive width between the frames; 3 feet should not be exceeded.

"gardens," attached to good houses in some of the once suburban, but now internal regions of London, where the houses stand some distance back from the formerly rural highway. These spaces might be cheaply enclosed with canvas, and cultivated as kitchen gardens, orchard houses, flower gardens, or ferneries, thus forming elegant, refreshing, and profitable vestibules between the highway and the house-door, and also serve as luxurious summer drawing-rooms. The only objection I foresee to these bright enclosures will be their tendency to encourage the consumption of tobacco.

The Discussion which followed the reading of the preceding paper at the Society of Arts.

A member asked if Mr. Williams had observed the effect of wind and rain on this material?

Mr. W. P. B. Shepheard said he was interested in a large square in London, and he had hoped to hear something about the cultivation of flowers in such places. Last year, they tried the experiment with several varieties of flower seeds, and they came up and bloomed well in the open ground without any protection whatever. In most London squares, the difficulty was to find anyone bold enough to try the experiment at all, and nothing but experience would prove what flowers would succeed and what would not. They were so successful last year that several fine bouquets were gathered in July and August, and sent to some of the gardening magazines, who expressed their astonishment that such good results were possible in the circumstances. If flowers would answer, there would, of course, be more encouragement to try vegetables. One of the practical difficulties which occurred to him, with regard to this plan, was that the screens would be somewhat unsightly, and then again they might shrink, from alteration in the temperature and getting wet and dry. He would repeat, however, that, for a very small expense in seeds, a very good show of hardy annuals and perennials might be obtained in July and August even in London.

Mr. C. Cooke said a flower-garden had recently been opened in Drury Lane, on the site of an old churchyard, to which children were admitted; and he wished a similar arrangement might be made in some of the squares in crowded neighborhoods, such as Golden Square, and especially in Lincoln's Inn Fields. There were lots of children playing about in the streets, and he wished the good example set by the Templars might be followed.

Mr. Liggins, as an old member of the Royal Horticultural Society, felt a great interest in this subject. Among his poorer neighbors in the district of Kensington, cottage and window gardening had been encouraged for some years past, prizes having been awarded to those who were most successful, much to their gratification. This was a novel idea, but he felt quite sure that it would enable those who adopted it to obtain the crops which had been described. There were many collateral advantages which it would bestow on the working classes if largely followed by them, especially the one mentioned by Mr. Williams, that those who devoted their spare time to the cultivation of fruit and flowers would not be so open to the attractions of the public-house. When traveling through the United States some years ago, he was much struck with the difference in appearance of the houses in districts where the Maine liquor law was in force, and soon learned to distinguish where it was adopted by the clean, cheerful look of the workmen's dwellings, the neatness of the gardens, and the presence of trees and flowers which, in other districts, were wanting. He was not a teetotaler himself, and was not advocating such restrictions, but he could not help noticing the contrast; and he felt sure that in all our large towns great progress in civilization and morals would be effected if such an attraction were offered to the working classes. He believed there was so much intelligence and good sense among them, that if they only knew what could be done in this way they would attempt it; and when an Englishman attempted anything, he generally succeeded.

Mr. William Botly said they were much indebted to Mr. Williams for having called attention to this important subject. He quite agreed with the observations of the last speaker, for his own experience in building cottages showed him that the addition of a piece of garden ground had an excellent effect on the social, moral, and religious welfare of the inmates. It kept them from the public-house, and the children who were brought up to hoe and weed their parents' gardens turned out the most industrious laborers on his property. He had known of instances where houses had been built with flat concrete roofs, and covered in with glass, so as to form a conservatory, in which vegetables and salads grow very well, and he believed the cost was little, if any, more than ordinary slating.

The Chairman (Lord Alfred Churchill) in moving a vote of thanks to Mr. Williams, said there could be no doubt that if his suggestion were adopted it would lead to great economy, and have many other attractions for the working classes. During the last few years they had heard a good deal about floriculture in windows, and no doubt it was an excellent proposal, but if they could add to this the growth of vegetables it would have economical advantages also. The proposal to erect temporary conservatories on the roofs of some of these small houses was an admirable one. He saw no reason why you should not have a peach tree growing against many a tall chimney; you would only want a metal-lined tub filled with a good mold; the warmth of the chimney would aid in promoting the growth of the tree, and it could be protected from the smoke and frost by this canvas. One point he should like to know was, whether the fabric would not become rotted by the weather, and perhaps it might be protected by tanning, or some chemical preparation. The effect of the canvas in maintaining an equable temperature was a great consideration; the difference stated by Mr. Williams, of about five degrees in winter, in many cases would be just enough to save the life of a plant. Practical gardeners knew the value of placing a covering over a peach tree in early spring to keep off the frosts, and also to protect it from the attacks of birds. It was also a curious fact that even a slip of wood or slate a few inches wide, put on the top of a wall to which a fruit tree was nailed, acted as a protection from frost. He trusted that Mr. Williams' idea would find favor among the working classes, and thought it was a subject the Royal Horticultural Society might well take up and offer prizes for. He hoped in a short time, when that Society had passed through a crisis which was impending, it might emerge in a condition to devote attention to this matter. It already offered prizes for small suburban flower-shows, but had not yet turned its attention to the larger class aimed at by Mr. Williams.

Mr. Botly said he had forgotten to mention that he had a friend, a very excellent gardener, who always loosened his fruit trees from the wall for about three weeks before the time of blooming. The consequence was, they did not get so much heat from the wall, and the bloom was two or three weeks later in forming. After the spring frosts, the trees were again nailed up close, and he never failed in getting an excellent crop, when his neighbors often had none.

Mr. Trewby wished to caution those who read the paper against using what was commonly known as paperhangers' canvas, because it was made of two materials, hemp and jute, and if a piece of it were put into water it would soon be nothing but a lot of strings, the jute being all dissolved. It did very well for paper-hanging, but would be quite unsuitable for this purpose.*

The vote of thanks having been passed—

Mr. Williams, in reply, said he had had a piece of this canvas stretched on a frame exposed all the winter, and the only result was to make it rather dirty. He stretched it as tightly as he could in putting it on, but when it got wet it became still more tight, and gave a little again on becoming dry. It bore the weight of the snow which had fallen very well, and two or three spadefuls had been added to try it. He had a note from Mr. Prim, saying that at the Houses of Parliament the screens last about two sessions, being washed once a week, and the destruction is due to the wringing. But there is really no occasion for this, for if

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*I have followed up Mr. Trewby's hint, and find that more than one quality of scrim is made. The best, made entirely of flax, costs rather more than the 2½*d*. stated in the estimate, but it is the cheapest practically. The best I have seen is that used in the Houses of Parliament.

you syringe the stuff well from the inside, you make it sufficiently clear to allow the air and light to pass through, and it would probably last many years. He had tried the experiment of dipping it in a very weak solution of tar, but this had the effect of matting together the fine filaments, so that it did not act so effectually as a strainer. It acted best when wet, because the fine particles of soot adhered to it, and moist weather was just the time when the greatest quantity of soot fell. It might be easily tried in London squares to aid in the growth of flowers; he found that the cabbage plants which were so protected throve remarkably well, and he had no doubt that if flowers were planted and a screen put over them until they were ready to bloom, it would be a great advantage. The action of a little pent on the top of a wall to protect fruit trees is very simple, and the explanation was afforded by the experiments of Dr. Wells on dew. The frosts which did the greatest mischief, were due to radiation from the ground on clear nights; and it would be found that if one thermometer were placed in a garden under an umbrella, and another on the open ground near it, the differences of temperature would be very considerable; on cloudy nights there was very little difference. Last night there was only a difference of 2°, but a few nights before it was 6°. The period of greatest cold might not probably be more than hour, but it would be sufficient to do a great deal of mischief, and anything which would check the radiation would have the required effect. In the case of loosening the fruit trees from the wall there was, probably, a double action; it prevented the tree being forced on by the warmth or the wall in the daytime, and also avoided the chilling effect at night, a rough wall being a good radiator, and sinking to a low temperature. He did not think there was much danger to be apprehended from wind, because the canvas being so open, the wind would pass freely through it; but he had not seen it subjected to any violent gale.

SOLIDS, LIQUIDS, AND GASES.

The growth of accurate knowledge is continually narrowing, and often obliterating, the broad lines of distinction that have been drawn between different classes of things. I well remember when our best naturalists regarded their "species" of plants and animals as fundamental and inviolable institutions, separated by well-defined boundaries that could not be crossed. Darwin has upset all this, and now we cannot even draw a clear, sharp line between the animal and vegetable kingdoms. The chemist is even crossing the boundary between these and the mineral kingdom, by refuting the once positive dictum that organic substances (*i.e.*, the compounds ordinarily formed in the course of vegetable or animal growth) cannot be produced directly from dead matter by any chemical device. Many of such organic compounds are now made in the laboratory from mineral materials.

We all know, broadly, what are the differences between solids, liquids, and gases, and, until lately, they have been very positively described as the three distinct states or modes of existence of matter. Mr. Crookes suggests a fourth. I will not discuss this at present, but merely consider the three old-established claimants to distinctive existence.

A solid is usually defined as a body made up of particles which hold together rigidly or immovably, in contradistinction to a fluid, of which the particles move freely over each other. "Fluids" is the general term including both gases and liquids, both being alike as regards the mobility of their particles.[*] At present, let us confine our attention to liquids and solids.

The theoretical or perfect fluid which is imagined by the mathematician as the basis of certain abstract reasonings has no real existence. He assumes (and the assumption is legitimate and desirable, provided its imaginary character is always remembered) that the supposed particles move upon each other with perfect freedom, without any friction or other impediment; but, as a matter of fact, all liquids exert some amount of resistance to their own flowing; they are more or less *viscous*, have more or less of that sluggishness in their obedience to the law of finding their own level which we see so plainly displayed by treacle or castor oil.

This viscosity, added to the friction of the liquid against the solid on which it rests, or in which it is enclosed, may become, even in the case of water, a formidable obstacle to its flow. Thus, if we make a hole in the side of a tank at a depth of 16 feet below the surface, the water will spout from that hole at the rate of 32 feet per second, but if we connect with this hole a long horizontal pipe of the same internal diameter as the hole, and then observe the flow from the outlet of the pipe, we shall find its velocity visibly diminished, and we shall be greatly deceived if we make arrangements for carrying swift-flowing water thus to any great distances.

Three or four years ago an attempt was made to supersede the water-carts of London by laying down on each side of the road a horizontal pipe, perforated with a row of holes opening towards the horse-way. The water was to be turned on, and from these holes it was to jet out to the middle of the road from each side, and thus water it all. I watched the experiment made near the Bank of England.

Instead of spouting across the road from all these holes, as it would have done from any *one* of them, it merely dribbled; the reason being that, in order to supply them all, the water must run through the whole of the long pipe with considerable velocity, and the viscosity and friction to be overcome in doing this nearly exhausted the whole force of water-head pressure. Many other similar blunders have been made by those who have sought to convey water-power to a distance by means of a pipe of such diameter as should demand a rapid flow through a long pipe.

The resistance which water offers to the stroke of the swimmer or the pull of the rower is partly due to its viscosity, and partly to the uplifting or displacement of some of the water. If it were perfectly fluid, our movements within it, and those of fishes, etc., would be curiously different; the whole face of this globe would be strangely altered in many respects.

I will not now follow up this idea, but leave it as a suggestion for the reader to work out for himself, by considering what would remain undone upon the earth if water flowed perfectly, without any internal resistance, or friction upon the earth's surface.

The degrees of approach to perfect fluidity vary greatly with different liquids.

Is there any such a thing as an absolute solid, or a body that has no degree of fluidity, the particles or parts of which will admit of no change of their relative positions, no movement upon each other without fracture of the mass? This would constitute perfect *rigidity*, or the opposite to *fluidity*.

Take a piece of copper or soft iron wire, about one eighth of an inch in diameter, or thereabouts, and bend it backwards and forwards a few times as rapidly as possible, but without breaking it; then, without loss of time, feel the portion that has been bent. It is hot—painfully so—if the experiment is smartly made. How may this be explained?

It is evident that in the act of bending there must have been a displacement of the relative positions of the particles of the metal, and the force demanded for the bending indicated their resistance to this movement upon each other; or, in other words, that there was friction between them, or something equivalent to such internal friction, and thus the mechanical force exerted in the bending was converted into heat-force.

Here, then, was fluidity, according to the above definition; not perfect fluidity, but fluidity attended with resistance to flow, or what we have agreed to call viscosity. But water also offers such resistance to flow, or viscosity, therefore the difference between iron or copper wire and liquid water as regards their fluidity is only a difference of degree, and not of kind; the demarcation between solids and liquids is not a broad, clearly-defined line, but a band of blending shade, the depths of tint representing varying degrees of viscosity.

Multitudes of examples may be cited illustrating the viscosity of bodies that we usually regard as types of solidity, such, for example, as the rocks forming the earth's crust. In the "Black Country" of South Staffordshire, which is undermined by the great ten-yard coal-seam, cottages, chimney-shafts, and other buildings may be seen leaning over most grotesquely, houses split down the middle by the subsidence or inclination of one side, great hollows in fields or across roads that were once flat, and a variety of other distortions, due to the gradual sinking of the rock-strata that have been undermined by the colliery workings. In some cases the rocks are split, but usually the subsidence is a bending or flowing down of the rocks to fill up the vacuity, as water fills a hollow, or "finds its own level."

I have seen many cases of the downward curvature of the roof of a coal-pit, and have been told that in some cases the surrounding pressure causes the floor to curve upwards, but have not seen this.

Earthquakes afford another example. The so-called solid crust of the earth is upheaved, and cast into positive billows that wave away on all sides from the centre of disturbance. The earth-billows of the great Lisbon earthquake of 1755 traveled to this country, and when they reached Loch Lomond, were still of sufficient magnitude to raise and lower its banks through a perpendicular range of two feet four inches.

It is quite possible, or, I may say, probable, that there are tides of the earth as well as of the waters, and the subject has occupied much attention and raised some discussion among mathematicians. If the earth has a fluid centre, and only a comparatively thin crust, as some suppose, there must be such tides, produced by the gravitation of the moon and sun.

Ice presents some interesting results of this viscosity. At a certain height, varying with latitude, aspect, etc., we reach the "snow line" of mountain slopes, above which the snow of winter remains unmelted during summer, and, in most cases, goes on accumulating. It soon loses its flocculent, flaky character, and becomes coherent, clear blue ice by the pressure of its own weight.

A rather complex theory has been propounded to explain this change—the theory of *regelation—i.e.*, re-freezing; a theory which assumes that the pressure first thaws a film of ice at the surface of contact, and that presently this re-freezes, and thus effects a healing or general solidification. Faraday found that two pieces of ice with moistened surfaces united if pressed together when at just about the temperature of freezing, but not if much colder. Tyndall has further illustrated this by taking fragments of ice and squeezing them in a mould, whereby they became a clear, transparent ball, or cake. Schoolboys did the like long before, when snowballing with snow at about the thawing point. Such snow, as we all remember, became converted into stony lumps when firmly pressed together. We also remember that in much colder weather no such cohesion occurred, but our snowballs remained powdery in spite of all our squeezing.

I am a sceptic as regards this theory of regelation. I believe that the true explanation is much simpler; that the crystals of snow or fragments of ice in these experiments are simply welded, as the smith unites two pieces of iron, by merely pressing them together when they are near their melting point. Other metals and other fusible substances may be similarly welded, provided they soften or become sufficiently viscous before fusing.

Platinum is a good example of this. It is infusible in ordinary furnaces, but becomes pasty before melting, and. therefore, one method adopted in the manufactore of platinum ingots or bars from the ore, is to precipitate a sort of platinum snow (spongy platinum) from its solution in acid, and then compress this metallic snow in red-hot steel moulds by means of pistons driven with great force. The flocculent metal thus becomes a solid, coherent mass, just as the flocculent ice became coherent ice in Tyndall's experiment or in making hard snowballs.

Wax, pitch, resin, and all other solid sthat fuse *gradually*, cohere, are weldable, or, in very plain language, "stick together," when near their fusing point.

I have made the following experiment to prove that when this so-called regelation of snow or ice-fragments occurs, the ice is viscous or plastic, like wax or pitch. A strong iron squirt, with a cylindrical bore of half an inch in diameter, is fitted with an iron piston. This piston is driven forth by a screw working in a collar at one end of the squirt. Into the other end is screwed a brass nozzle with an aperature about one twentieth of an inch diameter, tapering or opening inwards gradually to the half-inch bore.

Into this bore I place snow or fragments of ice, then, holding the body of the squirt firmly in a vice, I work the lever of the screw, and thus drive forward the piston and crush down the snow or ice-fragments, which presently become coherent and form a half-inch solid cylinder of clear ice. Applying still more pressure, this cylinder is forced like a liquid through the small orifice of the nozzle of the squirt, and it jets or spouts out as a thin stick of ice like vermicelli, or the "leads" of ever-pointed pencils, for the moulding of which the squirt was originally constructed.

I find that ice at 32° can thus be squirted more easily than beeswax of the same temperature, and such being the case, I see no reason for imagining any complex operation of regelation in the case of the ice, but merely regard the adhesion of two pieces of ice when pressed together as similar to the sticking together of two pieces of cobblers'-wax, or softened sealing-wax, or beeswax, or the welding of iron or glass when heated to their welding temperatures, *i.e.*, to a certain degree of incipient fluidity or viscosity.

If a leaden bullet be cut in half, and the two fresh-cut faces pressed forcibly together, they cohere at ordinary atmospheric temperatures, but we have no occasion for a regelation theory here. The viscosity of the lead accounts for all. At Woolwich Arsenal there is a monster squirt, similar to my little one. This is charged with lead, and, by means of hydraulic pressure, the lead is squired out of the nozzle as a cylindrical jet of any required diameter. This jet or stick of lead is the material of which the elongated cylindrical rifle bullets are now made.

But returning to the point at which we started, on the subject of ice, viz., its Alpine accumulation above the snow-line. If the snow-fall there exceeds the amount that is thawed and evaporated, it must either go on growing upward until it reaches the highest atmospheric region from which it falls, or is formed, or it must descend somehow.

If ice can be squirted through a syringe by mere hand-pressure, we are justified in expecting that it would be forced down a hill slope, or through a gully, or across a plain, by the pressure of its own weight when the accumulation is great. Such is the case, and thus are glaciers formed.

They are, strictly speaking, rivers or torrents of ice; they flow as liquid water does, and down the same channels as would carry the liquid surface drainage of the hills, were rain to take the place of snow. Like rivers, they flow with varying speed, according to the slope; like rivers, their current is more rapid in the middle than the sides; like rivers, they exert their greatest tearing force when squeezed narrow thorugh gullies; and, like rivers, they spread out into lakes when they come upon an open basin-like valley, with narrow outlet.

The Justedalsbrae of Norway is a great ice-lake of this character, covering a surface of about 500 square miles, and pouring down its ice-torrents on every side, wherever there is a notch or valley descending from the table-land it covers. The rate of flow of such downpouring glaciers varies from two or three inches to as many feet per day, and they present magnificent examples of the actual fluidity or viscosity of an apparently solid mass. This viscosity has been disputed, and attempts have been made to otherwise explain the motion of glaciers; but while it is possible that it may be assisted by varying expansion and contraction, the downflow due to viscosity is now recognized as unquestionably the main factor of glacier motion.

Cascades of ice may be sometimes seen. In the course of my first visit to Norway, I wandered alone over a very desolate mountain region towards the head of the Justedal, and unexpectedly came upon a gloomy lake, the Styggevand, which lies at the foot of a precipice-boundary of the great ice-field above named. Here, the ice having no sloping valley-trough by which to descend, poured over the edge of the precipice as a great overhanging sheet or cornice, which bent down as it was pushed forward, and presented on the convex side of the sheet some fine blue cracks, or "crevasses" as they are called. These gradually widened and deepened, until the overhanging mass broke off and fell into the lake, on the surface of which I saw the result, in the form of several floating icebergs that had previously fallen.

Something like this, on a small scale, may be seen at home on the edge of a house roof, on which there has been an accumulation of snow; but, in this case, it is rather sliding than flowing that has made the cornice; but its *down-bending* is a result of viscosity.

These and a multitude of other facts that might be stated, many of which will occur to the reader, prove clearly enough that the solid and liquid states of matter are not distinctly and broadly separable, but are connected by an intermediate condition of viscosity.

We now come to the question whether there is any similar continuity between liquids and gases. Ordinary experience decidedly suggests a negative answer. We can point to nothing within easy reach that has the properties of a liquid and gaseous half-and-half; that stands between gases and liquids as pitch and treacle stand between solids and liquids.

Some, perhaps, may suggest that cloud-matter—London fog, for example—is in such an intermediate state. This, however, is not the case. White country fog, ordinary clouds, or the so-called "steam" that is seen assuming cloud forms as it issues from the spout of a tea-kettle or funnel of a locomotive, consists of minute particles of water suspended in air, as solid particles of dust are also suspended. It has been called "vesicular vapor," on the supposition that it has the form of minute vesicles, like soap-bubbles on a very small scale, but this hypothesis remains unproven. London fog consists of similar particles, varnished with a delicate film of coal-tar, and intersprinkled with particles of soot.

In order to clearly comprehend the above-stated question, we must define the difference between liquids and gases.

In the first place, they are both fluids, as already agreed. What, then, is the essential difference between liquid fluidity and gaseous fluidity? The expert in molecular mathematics, discoursing to his kinematical brethren, would produce a tremendous reply to this question. He would describe the oscillations, gyrations, collisions, mean free paths, and mutual obstructions of atoms and molecules, and, by the aid of a maddening array of symbols, arrive at the conclusion that gases, unless restrained, expand of their own accord, while liquids retain definite limits or dimensions.

The matter-of-fact experimentalist demonstrates the same by methods that are easily understood by anybody. I shall, therefore, both for my own sake and my readers', describe some of the latter.

In the first place, we all see plainly that liquids have a surface, *i.e.*, a well-defined boundary, and also that gases, unless enclosed, have not. But as this may be due to the invisibility of the gas, we must question it further. The air we breathe may be taken as a type of gases, as water may of liquids. It has weight, as we may prove by weighing a bottle full of air, then pumping out the contents, weighing the empty bottle, and noting the difference.

Having weight, it presses towards the earth, and is squeezed by all that rests above it; thus the air around us is constrained air. It is very compressible, and is accordingly compressed by the weight of all the air above it.

This being understood, let us take a bottle full of water and another full of air, and carry them both to the summit of Mont Blanc, or to a similar height in a balloon. We shall then have left nearly half of the atmosphere below, and thus both liquid and gas will be under little more than half of the ordinary pressure. What will happen if we uncork them both? The liquid will still display its definite surface, and remain in the bottle, but not so the gas. It will overflow upwards, downwards, or sideways, no matter how the bottle is held, and if we had tied an empty bladder over the neck before uncorking, we should find this overflow or expansion of the gas exactly proportionate to the removal of pressure, provided the temperature remained unaltered. Thus, at just half the pressure under which a pint bottle was corked, the air would measure exactly one quart, at one-eighth of the pressure one gallon, and so on.

We cannot get high enough for the latter expansion, but can easily imitate the effect of further elevation by means of an air-pump. Thus, we may put one cubic inch of air into a bladder of 100 cubic inches capacity, then place this under the receiver of an air-pump, and reduce the pressure outside the bladder to $\frac{1}{100}$th of its original amount. With such atmospheric surrounding, the one cubic inch of air will plump out the flaccid bladder, and completely fill it. The pumpability of the air from the receiver shows that it goes on overflowing from it into the piston of the pump as fast as its own elastic pressure on itself is diminished.

Numberless other experiments may be made, all proving that all gases are composed of matter which is not merely incohesive, but is energetically self-repulsive; so much so, that it can only be retained within any bounds whatever by means of some external pressure or constraint. For aught we know *experimentally*, the gaseous contents of one of Mr. Glaisher's baloons would outstretch itself sufficiently to occupy the whole sphere of space that is spanned by the earth's orbit, provided that space were perfectly vacuous, and the baloon were burst in the midst of it, the temperature of the expanding gas being maintained.

Here, then, in this self-repulsiveness, instead of self-cohesion, this absence of self-imposed boundary or dimensions, we have a very broad and well-marked distinction between gases and liquids, so broad that there seems no bridge that can possibly cross it. This was believed to be the case until recently. Such a bridge has, however, been built, and rendered visible, by the experimental researches of Dr. Andrews; but further explanation is required to render this generally intelligible.

Until quite lately it was customary to divide gases into two classes—"permanent gases" and "condensable gases," or "vapors." Gaseous water or steam was usually described as typical of the latter; oxygen, hydrogen, or nitrogen of the former. Earlier than this, many other gases were included in the permanent list; but Faraday made a serious inroad upon this classification when he liquefied chlorine by cooling and compressing it. Long after this, the gaseous elements of water, and the chief constituents of air, oxygen, hydrogen, and nitrogen, resisted all efforts to condense them; but now they have succumbed to great pressure and extreme cooling.

We thus arrive at a very broad generalization, viz., that all gases are physically similar to steam (I mean, of course, "dry steam," *i.e.*, true invisible steam, and not the cloudy matter to which the name of steam is popularly given), that they are all formed by raising liquids above their boiling point, just as steam is formed when we boil water and maintain the steam above the boiling-point of the water.

But some liquids boil at temperatures far below that at which others freeze; liquid chlorine boils at a temperature below that of freezing water, and liquid carbonic acid below even that of freezing mercury, and liquid hydrogen far lower still. These are cases of boiling, nevertheless, though it seems a paradox according to the ideas we commonly attach to this word. But such ideas are based on our common experience of the properties of our commonest of liquids, viz., water.

When water boils under the conditions of our ordinary experience, the passage from the liquid to the gaseous state is a sudden leap, with no intermediate state of existence that we are able to perceive; and the conditions upon which water is converted into steam—the liquid into the gas—while both are at the bottom of our atmospheric ocean, are such as to render an intermediate condition rationally, as well as practically, impossible.

We find that the expansive energy by which the steam is enabled to resist atmospheric pressure is conferred upon it by its taking into itself, and utilizing for its expansive efforts a large amount of calorific energy. When any given quantity of water is converted into steam, under ordinary circumstances, its bulk *suddenly* becomes above 1700 times greater—a cubic inch of water forms about a cubic foot of steam, and nearly 1000 degrees of heat (966·6) disappears *as temperature*. Otherwise stated, we must give to the cubic inch of water at 212° as much heat as would raise it to a temperature of 212 plus 966·6, or 1,178·6°, if it remained liquid. This is about the temperature of the glowing coals of a common fire; but the steam that has thus taken enough heat to make the water red-hot is still at 212°—no *hotter* than the water was while boiling.

This heat, which thus ceases to exhibit itself as *temperature*, is otherwise occupied. Its energy is partly devoted to the work of increasing the bulk of the water to the above-named extent, and partly in conferring on the steam its gaseous specialty—that is, in overcoming liquid cohesion, and substituting for it the opposite property of internal repulsive energy which is characteristic of gases. My reasons for thus defining and separating these two functions of the so-called "latent" heat will be seen when we come to the philosophy of the interesting researches of Dr. Andrews.

As already explained, all gases are now proved to be analogous to steam, they are matter expanded and rendered self-repulsive by heat. All *elementary* matter may exist in either of the three forms—solid, liquid, or gas, according to the amount of heat and pressure to which it is subjected. I limit this wide generalization to *elementary* substances for the following reasons:

Many compounds are made up of elements so feebly held together that they become "dissociated" when heated to a temperature below their boiling-point; or, their condition may be otherwise defined by stating that the bonds of chemical energy, which hold their elements together, are weaker than the cohesion which binds and holds them in the condition of solid or liquid, and are more easily broken by the expansive energy of heat.

To illustrate this, let us take two common and well-known oils—olive oil and turpentine. The first belongs to the class of "fixed oils," and second to the "volatile oils." If we apply heat to liquid turpentine, it boils, passes into the state of gaseous turpentine, which is easily condensible by cooling it. If the liquid result of this condensation is examined, we find it to be turpentine as before. Not so with the olive oil. Just as this reaches its boiling point, the heat, which would otherwise convert it into olive-oil vapor, begins to dissociate its constituents, and if the temperatutre be raised a little higher, we obtain some gases, but these are the products of decomposition, not gaseous olive oil. This is called "destructive" distillation.

In olive oil, the boiling-point and dissociation point are near to each other. In the case of glycerine, these points so nearly approximate that, although we cannot distil it unbroken under ordinary atmospheric pressure, we may do so if some of this pressure is removed. Under such diminished pressure, the boiling-point is brought down below the dissociation point, and condensible glycerine gas comes over without decomposition.

Sugar affords a very interesting example of dissociation, commencing far below the boiling-point, and going on gradually and visibly, with increasing rapidity as the temperature is raised. Put some white sugar into a spoon, and heat the spoon gradually over the smokeless gas-flame or spirit-lamp. At first the sugar melts, then becomes yellow (barley sugar); this color deepens to orange, then red, then chestnut-brown, then dark brown, then nearly black (caramel), then quite black, and finally it becomes a mere cinder. Sugar is composed of carbon and water; the heat dissociates this compound, separates the water, which passes off as vapor, and leaves the carbon behind. The gradual deepening of the color indicates the gradual carbonization, which is completed when only the dry insoluble cinder remains. An appearance of boiling is seen, but this is the boiling of the dissociated water, not of the sugar.

The dissociation temperature of water is far above its boiling-point. It is 5072° Fahr., under conditions corresponding to those which make its boiling-point 212°. If we examine the variations of the boiling-point of water, as the atmospheric pressure on its surface varies, some curious results follow. To do this the reader must endure some figures. They are extremely simple, and perfectly intelligible, but demand just a little attention.

Following are three columns of figures. The first represents atmospheres of pressure—*i.e.*, taking our atmospheric pressure when it supports 30 inches of mercury in the barometer tube as a unit, that pressure is doubled, trebled, etc., up to twenty times in the first column. The second column states the temperature at which water boils when under the different pressures thus indicated. The third column, which is the subject for special study just now, shows how much we must rise the temperature of the water in order to make it boil as we go on adding atmospheres of pressure; or, in other words, the increase of temperature due to each increase of one atmosphere of pressure. The figures are founded on the experiments of Regnault.

Pressure in Atmospheres	Temperature, F. °	Rise of Temperature for each additional Atmosphere
1	212	
2	249·5	37·5
3	273·3	23·8
4	291·2	17·9
5	306·0	14·8
6	318·2	12·2
7	329·6	11·4
8	339·5	9·9
9	348·4	8·9
10	356·6	8·2
11	364·2	7·6
12	371·1	6·9
13	377·8	6·7
14	384·0	6·2
15	390·0	6·0
16	395·4	5·4
17	400·8	5·4
18	405·9	5·1
19	410·8	4·9
20	415·4	4·6

It may be seen from the above that, with the exception of one irregularity, there is a continual diminution of the additional temperature which is required to overcome an additional atmosphere of pressure, and if this goes on as the pressure and temperatures advance, we may ultimately reach a curious condition—a temperature at which additional pressure will demand no additional temperature to maintain the gaseous state; or, in other words, a temperature may be reached at which no amount of pressure can condense steam into water, or at which the gaseous and liquid states merge or become indifferent.

But we must not push this mere numerical reasoning too far, seeing that it is quite possible to be continually approaching a given point, without ever reaching it, as when we go on continually halving the remaining distance. The figures in the above do not appear to follow according to such a law—nor, indeed, any other regularity. This probably arises from experimental error, as there are discrepancies in the results of different investigators. They all agree, however, in the broad fact of the gradation above stated. Dulong and Arago, who directed the experiments of the French Government Commission for investigating this subject, state the pressure at 20 atmospheres to be 418·4, at 21=422·9, at 22=427·3, at 23=431·4, and at 24 atmospheres, their highest *experimental* limit, 435·5, thus reducing the rise of temperature between the 23d and 24th atmospheres to 4·1.

If we could go on heating water in a transparent vessel until this difference became a vanishing quantity, we should probably recognize a visible physical change coincident with this cessation of condensibility by pressure; but this is not possible, as glass would become red-hot and softened, and thus incapable of bearing the great pressure demanded. Besides this, glass is soluble in water at these high temperatures.

If, however, we can find some liquid with a lower boiling-point, we may go on piling atmosphere upon atmosphere of elastic expansive pressure, as the temperature is raised, without reaching an unmanageable degree of heat. Liquid carbonic acid, which, under a single atmosphere of pressure, boils at 112° below the zero of our thermometer, may thus be raised to a temperature having the same relation to its boiling-point that a red-heat has to that of water, and may be still confined within a glass vessel, provided the walls of the vessel are sufficiently thick to bear the strain of the elastic outstriving pressure. In spite of its brittleness glass is capable of bearing an enormous strain *steadily applied,* as may be proved by trying to break even a mere thread of glass by direct pull.

Dr. Andrews thus treated carbonic acid, and the experiment, as I have witnessed its repetition, is very curious.

A liquid occupies the lower part of a very strong glass tube, which appears empty above. But this apparent void is occupied by invisible carbonic acid gas, evolved by the previous boiling of the liquid carbonic acid below. We start at a low temperature—say 40° Fahr. Then the temperature is raised; the liquid boils until it has given off sufficient gas or vapor to exert the full expansive pressure or tension due to that temperature. This pressure stops the boiling, and again the surface of the liquid is becalmed.

This is repeated at a higher temperature, and thus continued until we approach nearly to 88° Fahr., when the surface of the liquid loses some of its sharp outline. Then 88° is reached, and the boundary between liquid and gas vanishes; liquid and gas have blended into one mysterious intermediate fluid; an indefinite fluctuating something is there filling the whole of the tube—an etherealized liquid or a visible gas. Hold a red-hot poker between your eye and the light; you will see an upflowing wavy movement of what appears like liquid air. The appearance of the hybrid fluid in the tube resembles this, but is sensibly denser, and evidently stands between the liquid and gaseous states of matter, as pitch or treacle stands between solid and liquid.

The temperature at which this occurs has been named by Dr. Andrews the "*critical temperature*"; here the gaseous and liquid states are "*continuous*," and it is probable that all other substances capable of existing in both states have their own particular critical temperatures.

Having thus stated the facts in popular outline, I shall conclude the subject by indulging in some speculations of my own on the philosophy of these general facts or natural laws, and on some of their possible consequences.

As already stated, the conversion of water into steam under ordinary atmospheric pressure demands 966·6° of heat over and above that which does the work of raising the water to 212°, or, otherwise stated, as much heat is at work in a given weight of steam at 212°, as would raise the same quantity of water to 1178·6° if it remained liquid.

James Watt concluded from his experiments that a given weight of steam, whatever may be its density, or, in other words, under whatever pressure it may exist, contains the same quantity of heat. According to this, if we reduced the pressure sufficiently to bring down the boiling-point to 112°, instead of 212°, the latent heat of the steam thus formed would be 1066·6° instead of 966·6°, or if, on the other hand, we placed it under sufficient pressure to raise the boiling-point to 312°, the latent heat of the steam would be reduced to 866·6°, *i.e.*, only 866·6° more would be required to convert the water into steam. If the boiling-point were 412°, as it is between 19 and 20 atmospheres of pressure, only 766·6° more heat would be required, and so on, till we reached a pressure which raised the boiling-point to 1178·6°; the water would then become steam without further heating, *i.e.*, the critical point would be reached, and thus, if Watt is right, we can easily determine, theoretically, the critical temperature of water.*

Mr. Perkins, who made some remarkable experiments upon very high pressure steam many years ago, and exhibited a steam gun at the Adelaide Gallery, stated that red-hot water does not boil; that if the generator be sufficiently strong to stand a pressure of 60,000 lbs. load on the safety, valve, the water may be made to exert a pressure of 56,000 lbs. on the square inch at a cherry-red heat without boiling. He made a number of rather dangerous experiments in thus raising water to a red-heat, and his assertion that red-hot water does not boil is curious when viewed in connection with Dr. Andrews' experiments.

I cannot tell how he arrived at this conclusion, having been unable to obtain the original record of his experiments, and only quote the above second hand. It is worthy of remark that the temperature he names is about 1170°, or that which, if Watt is right, must be the critical temperature of the water. Perkins' red-hot water would not boil, being then in the intermediate condition.

So far, we have a nice little theory, which not only shows how the critical state of water must be reached, but also its precise temperature; but all this is based on the assumption that Watt made no mistake.

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* Watt's own figure for the latent heat of steam at 212° was 950°, but I adopt that which is now generally accepted.

Unfortunately for the simplicity of this theory, Regnault states that *his* experiments contradict those of Watt, and prove that the latent heat of steam does not diminish just in the same degree as the boiling-point is raised, but that instead of this the diminution of the latent heat progresses 30½ per cent more slowly than the rise of temperature, so that, instead of the latent heat of steam between boiling-points of 212° and 312° falling from 966·6° to 866·6° it would only fall to 895·1° or 69·5° of latent heat for every 100° of temperature.

If this is correct, the temperature at which the latent heat of steam is reduced to zero is much higher than 1178·6°, and is, in fact, a continually receding quantity never absolutely reached; but I am not prepared to accept these figures of Regnault as implicitly as is now done in text-books (I was nearly saying "as is now the fashion"), seeing that they are not the actual figures obtained by his experiments, but those of his "empirical formulæ" based upon them. His actual experimental figures are very irregular; thus, between steam temperature of 171·6° and 183·2° a difference of 11·6°, the experimental difference in the latent heat came out as 4·7°; between steam temperature of 183·2° and 194·8°, or 11·6° again, the latent heat difference is tabulated as 8·0°.

Regnault's experiments were not carried to very high temperatures and pressures, and indicate that as these advance the deviation from Watt's law diminishes, and may finally vanish at about 1500° or 1600°, where the latent heat would reach zero, and there, according to the above, the critical temperature would be reached. Any additional heat applied after this will have but one function to perform, viz., the ordinary work of increasing the bulk of the heated body without doing anything further in the way of conferring upon it any new self-repulsive properties.

Our notions of solids, liquids, and gases are derived from our experiences of the state of matter here upon this earth. Could we be removed to another planet, they would be curiously changed. On Mercury water would rank as one of the condensible gases; on Mars, as a fusible solid; but what on Jupiter?

Recent observations justify us in regarding this as a miniature sun, with an external envelope of cloudy matter, apparently of partially condensed water, but red-hot, or probably still hotter within. His vaporous atmosphere is evidently of enormous depth, and the force of gravitation being on his visible outer surface two and a half times greater than that on our earth's surface, the atmospheric pressure in descending below this visible surface must soon reach that at which the vapor of water would be brought to its critical condition. Therefore we may infer that the oceans of Jupiter are neither of frozen liquid nor gaseous water, but are oceans or atmospheres of critical water. If any fish-birds swim or fly therein they must be very critically organized.

As the whole mass of Jupiter is three hundred times greater than that of the earth, and its compressing energy towards the centre proportional to this, its materials, if similar to those of the earth and no hotter, would be considerably more dense, and the whole planet would have a higher specific gravity; but we know by the movement of its satellites that, instead of this, its specific gravity is less than a fourth of that of the earth. This justifies the conclusion that it is intensely hot, for even hydrogen, if cold, would become denser than Jupiter under such pressure.

As all elementary substances may exist as solids, liquids, or gases, or critically, according to the conditions of temperature and pressure, I am justified in hypothetically concluding that Jupiter is neither a solid, a liquid, nor a gaseous planet, *but a critical planet,* or an orb composed internally of dissociated elements in the critical state, and surrounded by a dense atmosphere of their vapors, and those of some of their compounds, such as water. The same reasoning applies to Saturn and the other large and rarefied planets.

The critical temperature of the dissociated elements of the sun is probably reached at the base of the photosphere, or that region revealed to us by the sun-spots. When I wrote "The Fuel of the Sun," thirteen or fourteen years ago, I suggested, on the above grounds, the then heretical idea of the red-heat of Jupiter, Saturn, Uranus, and Neptune, and showed that all such compounds as water must be dissociated at the base of the sun's atmosphere; but being then unacquainted with the existence of this critical state of matter, I supposed the dissociated elements to exist as gases with a small solid nucleus or kernel in the centre.

Applying now the researches of Dr. Andrews to the conditions of solar existence, as I formerly applied the dissociation researches of Deville, I conclude that the sun has no nucleus, either solid, liquid, or gaseous, but is composed of dissociated matter in the critical state, surrounded, first, by a flaming envelope due to the re-combination of the dissociated matter, and outside of this another envelope of vapors due to this combination.

MURCHISON AND BABBAGE.

The curious contrast of character presented by these two eminent men, and the very different course of their lives, conveys a striking lesson to all those superficial thinkers and unthinking talkers who make sweeping generalizations concerning human character; who assume as a matter of course that any man who writes poetry must be merely a dreamer of day-dreams, incapable of transacting any practical daily business, and not at all reliable in money matters; whose eyes are always "in a fine frenzy rolling"; that he is, in short, a sort of amiable, harmless lunatic. All actors, according to such people, are dissipated spendthrifts; and if Sims Reeves, or any other public performer, is prevented by delicate larynx or other indisposition from appearing, they look knowing, shrug their shoulders, wink wisely, and assume, without the faintest shadow of evidence, that he is drunk.

In like manner they set up a typical philosopher of their own manufacture, and attribute his imaginary character to all who devote themselves to science. Their philosopher is a musty, dried-up, absent-minded pedant, whose ordinary conversation is conducted in words of seven syllables, who is always lost in profound abstractions; takes no interest in common things; regards music, dancing, play-acting, poetry, and every cheerful pursuit as frivolous and contemptible—a creature who never makes a joke, seldom laughs, and who in matters of business is even more incapable than the poet.

The singular contrast of character presented by Babbage and Murchison affords at once a most complete refutation of such generalizations. Here were two men, both philosophers, one the very type of amiability, suavity, and all conceivable polish, the very perfection of a courtier, but differing from the vulgar courtier of the Court in this respect, that his high-toned courtesy was not bestowed upon kings only, but also upon all his human brethren, and with especial gracefulness upon those whose rank was below his own.

I doubt whether there is any man now living, or has lived during this generation, that could equal Sir Roderick Murchison in the art of distributing showers of compliments upon a large number of different people in succession, and making each recipient delightfully satisfied with himself. In his position as Chairman to the Geological Section of the British Association, he did this with marvelous tact, without the least fulsomeness or repetition, or any display of patronizing. Every man who read a paper before that section was better than ever satisfied with the great merits and vast importance of his communication, after hearing the Chairman's comments upon it. None but a most detestably strong-minded and logical brute could resist the insinuating flattery of Sir Roderick.

How different was poor Babbage! Who that attends any sort of scientific gatherings has not seen Sir Roderick? but who in the world, excepting the organ-grinders and the police magistrate has ever seen Babbage, or even his portrait? What a contrast between the seclusion and the public existence; between the hedgehog bristles and the velvet softness, of the one and the other!

Those who were on intimate terms with Babbage (I have never met or heard of such a person) could probably tell us that all his irritability and roughness were outside, and that, in the absence of organ-grinders, he was a kind and amiable gentleman; but, even admitting this, the contrast between the two philosophers is as great as could well be found between any two men following the most widely divergent studies or professions.

Those who would reply that mathematics and geology are such different studies have only to go a little further back on the death-roll, and they will find the name of De Morgan, a pure mathematician, like Babbage. He was a man of exuberant fun and humor, and so far from hating music of either a humble or pretentious character, was a highly accomplished musician, both theoretical and practical, and if we are to believe confidential communications, one of his favorite instruments was the penny whistle, on which he was a most original and peculiar performer.

I had not intended to reprint the above, which was written just after the death of Murchison and Babbage, but the comments that have recently followed the death of Darwin induce me to do so.

Many have expressed their surprise at the unanimous expressions of Darwin's friends concerning the geniality of his disposition, his gentleness, cheerfulness; his *genuine* humility and simplicity of character.

A third type of character is here presented, and that which corresponds most correctly with the true ideal of a modern philosopher, also represented by that great master of experimental science, Faraday. In both of these there was the full measure of Murchison's amiability, but without the courtly polish of the ex-soldier. Philosophic meditation and close application to original research may, and often does, induce a certain degree of shyness due to a consciousness of the social disqualification which arises from that inability to fulfil all the demands for small attentions which constitute conventional politeness; a disability due to habits of consecutive thought and mental abstraction.

A sensitive and amiable man would suffer much pain on finding that he had neglected to supply the small wants of the lady sitting next to him at a dinner party, and would withdraw himself from the risk of repeating such unwitting rudeness. This holding back from ordinary society, though really due to a conscientious sense of social duty and tender regard for the feelings of others, is too often referred to a churlish unsociality or arrogant assumption of superiority.

If Newton really did mistake the lady's finger for a tobacco-stopper, depend upon it the pain he suffered was far more acute than that which he inflicted, and was suffered over and over again whenever the incident was recollected.

ATMOSPHERE *versus* ETHER.

ONE of the most remarkable meteors of which we have a reliable record appeared on February 6, 1818. Several accounts of it were published, the fullest being that in *The Gentleman's Magazine* of the time. (I may here add, parenthetically, that one reason why I have especial pleasure in writing these notes is that they contribute something towards the restoration of the ancient status of this magazine, which was at one time the only English serial that ventured upon any notable degree of exposition of *popular* science.)

Upon the data supplied by this account, Mr. Joule has calculated the height of the meteor to have been 61 miles above the surface of the earth, and he states that "this meteor is one of the few that have been seen in the daytime, and is also interesting as having been one of the first whose observation afforded materials for the estimation of its altitude." It was seen in the neighborhood of Cambridge at 2 P.M., also at Swaffham in Norfolk, and at Middleton Cheney near Banbury. The distance between this and Cambridge is sufficient to afford a measurement of its height, provided its position above the horizon at both places was determined with tolerable accuracy.

According to the orthodox text-books, the atmosphere of this earth terminates at a height of about 45 or 50 miles, or, if not absolutely ended there, it ceases to be of appreciable density anywhere above this elevation.

But here we have a fact which flatly contradicts the calculation. At 61 miles above the earth's surface there must be atmospheric matter of sufficient density to offer to the passage of this meteor through it an amount of resistance which produced an intense white heat, visible by its luminosity in broad daylight.

In the above-quoted paper, read by Mr. Joule before the Manchester Literary and Philosophical Society on December 1, 1863, he refers to subsequent observations and estimates 116 miles as "the elevation at which meteors in general are first observed"—*i.e.*, where our atmosphere is sufficiently dense to generate a white-heat by the resistance it offers to the rapidly flying meteor.

It is curious to observe how, in dealing with actual physical facts, a mathematician of the solid practical character of Joule becomes compelled to practically throw overboard the orthodox theory of limited atmospheric extension. Here, in making his calculations of the resistance of atmospheric matter at this elevation, be bases them on the assumption of a decrease of density at the rate of "one quarter for every seven miles," and indicates no limit at which this rate shall vary. Very simple arithmetic is sufficient to show that this leads us to the unlimited atmospheric extension, for which I have contended we may go on for ever taking off a quarter at every seven miles, and there will still remain the three quarters of the quantity upon which we last operated, or, more practically stated, we shall thus go on seven after seven until we reach the boundaries of the atmospheric grasp of the gravitation of some other sphere.

Surely the time has arrived for the full reconsideration of this fundamental question of whether the universe is filled with atmospheric matter or is the vacuum of the molecular mathematicians plus the imaginary "ether," which has been invented by its mathematical creators only to extricate them from the absurd dilemma into which they are plunged when they attempt to explain the transmission of light and heat by undulations traveling through space containing nothing to undulate.

They have filled it with immaterial matter evolved entirely from their own consciousness, which they have gratuitously endowed with whatever properties are required for the fitting of their theories—properties that are self-contradictory and without any counterpart in anything seen or known outside of the fertile imagination of these reckless theorists.

We know of nothing that can penetrate every form of matter without adding either to its weight or its bulk; we know of nothing that can communicate motion to ponderable matter without itself being ponderable—*i.e.*, having the primary property of matter, viz., mass, or weight, and consequent *vis viva* when moving; we know of nothing that can set bodies in motion without proportionally resisting the motion of bodies through it; and if the waving of the ether is (as Tyndall describes it) "as real and as truly mechanical as the breaking of sea-waves upon the shore," the material of the breakers must be like the "jelly" to which he compares it, and have some viscosity, or resistance to penetration, or pushing aside.

We have not a shadow of direct evidence of the existence of the "interatomic" spaces occupied by the other, and in the midst of which the atoms are made to theoretically swing, nor even of the existence of the atoms themselves.

The "ether" of to-day, with its imaginary penetration and its material action without material properties, has merely taken the place of the equally imaginary phlogiston, caloric, electric, and magnetic fluids, the "imponderables" of the past. I have little doubt that ere long the modern modification of these physical superstitions will share their fate, and we shall all adopt the simple conception that heat, light, end electricity are, like sound, merely transmissible states or affections of matter itself regarded bodily, as it is seen and felt to exist.

This may possibly throw a good many mathematicians out of work—or into more useful work; but, however that may be, it will certainly aid the general diffusion of science as the intellectual inheritance of every human being. At present the explanations of the simple phenomena of light and heat are incomparably more difficult to understand and to account for than the facts which they attempt to elucidate.

A NEGLECTED DISINFECTANT.

When the household of our grandmothers was threatened with infection, the common practice was to sprinkle brimstone on a hot shovel or on hot coals on a shovel, and carry the burning result through the house. But now this simple method of disinfecting has gone out of fashion without any good and sufficient reason. The principal reason is neither good nor sufficient, viz., that nobody can patent it and sell it in shilling and half-crown bottles.

On September 18th last, M. d'Abbadie read a paper at the Academy of Sciençes on "Marsh Fevers," and stated that in the dangerous regions of African river mouths immunity from such fevers is often secured by sulphur fumigations on the naked body. Also that the Sicilian workers in low ground sulphur mines suffer much less than the rest of the surrounding population from intermittent fevers. M. Fouqué has shown that Zephyria (on the volcanic island of Milo or Melos, the most westerly of the Cyclades), which had a population of 40,000 when it was the centre of sulphur-mining operations, became nearly depopulated by marsh fever when the sulphur-mining was moved farther east, and the emanations prevented by a mountain from reaching the town. Other similar cases were stated.

It is well understood by chemists that bleaching agents are usually good disinfectants; that which can so disturb an organic compound as to destroy its color, is capable of either arresting or completing the decompositions that produce vile odors and nourish the organic germs or ferments which usual accompany, or, as some affirm, cause them. Sulphurous acid is, next to hypochlorous acid, one of the most effective bleaching agents within easy reach.

I should add that sulphurous acid is the gas that is *directly* formed by burning sulphur. By taking up another dose of oxygen it becomes sulphuric acid, which, combined with water, is oil of vitriol. The bleaching and disinfecting action of the sulphurous acid is connected with its activity in appropriating the oxygen which is loosely held or being given off by organic matter. Chlorine and hypochlorous acid (which is still more effective than chlorine itself) act in the opposite way, so do the permanganates, such as Condy's fluid, etc. They supply oxygen in the presence of water. It is curious that opposite actions should produce like results. A disquisition on this and its suggestions would carry me beyond the limits of a note.

ANOTHER DISINFECTANT.

THE above-named disinfectants are objectionable on account of their own odors and their corrosive action. Both sulphurous acid and hypochlorous acid (the active principle of the so-called "chloride of lime") have a disagreeable habit of rusting iron and suggesting antique green bronzes by their action on brass ornaments. Under serious conditions this should be endured, but in many cases where the danger is not already developed, the desired end may be attained without these annoyances.

Sulphate of copper, which is not patented or "brought out" by a limited company, may be bought at its fair retail value of 6d. or less per lb. (the oil-shop name for it is "blue vitriol"), in crystals, readily soluble in water.

I have lately used it in the case of a trouble to which English households are too commonly liable, and one that has in many cases done serious mischief. The stoppage of a soil-pipe caused the overflow of a closet, and a consequent saturation of floor boards, that in time would probably have developed danger by nourishing and developing those germs of bacteria, bacilli, etc., which abound in the air, and are ready to increase and multiply wherever their unsavory food abounds.

By simply mopping the floor with a solution of these green crystals, and allowing it to soak well into the pores of the wood, they cease to become a habitat for such microscopic abominations. The copper-salt poisons the poisoners.

Dr. Burg goes so far as to recommend that building materials, articles of furniture, and clothing, etc., should be injected with sulphate of copper, in order to avert infection, and in support of this refers to the immunity of workers in copper from cholera, typhoid fever, and infectious diseases generally.

I agree with him to the extent of suggesting the desirability of occasionally mopping house floors with this solution. Its visible effects on the wood are first to stain it with a faint green tinge which gradually tones down to a brown stain, giving to deal the appearance of oak, a change which has no disadvantage from an artistic point of view. If the wood is already tainted with organic matter capable of giving off sulphureted hydrogen, the darkening change is more rapid and decided, owing to the formation of sulphide of copper.

The solution of sulphate should not be put into iron or zinc vessels, as it rapidly corrodes them, and deposits a non-adherent film of copper. It will even disintegrate common earthenware, by penetrating the glaze, and crystallizing within the pores of the ware, but this is a work of time (weeks or months). Stoneware resists this, and wooden buckets may be used safely. It is better to keep the crystals and dissolve when required. Ordinary earthenware may be used with impunity if washed immediately afterwards.

ENSILAGE.

This subject has been largely expounded and discussed lately in the *Times* and other newspapers. As most of my readers are doubtless aware, it is simply a substitute for haymaking, by digging pits, paving and building them round with stone or concrete, then placing the green fodder therein and covering it over with sufficient earth to exclude the air.

We are told that very inferior material (such as coarse maize grass mixed with chaff) when thus preserved gives better feeding and milking results than good English hay.

I may mention a very humble experience of my own that bears upon this. When a boy, I was devoted to silkworms, and my very small supply of pocket-money was over-taxed in the purchase of exorbitantly small pennyworths of mulberry leaves at Covent Garden. But a friend in the country had a mulberry tree, and at rather long intervals I obtained large supplies, which, in spite of all my careful wrapping in damp cloths, became rotted in about ten days. I finally tried digging a hole and burying them. They remained fresh and green until all my silkworms commenced the working and fasting stage of their existence. This was ensilage on a small scale.

The correspondence in the newspapers has suggested a number of reasons why English farmers do not follow the example of their continental neighbors in this respect; climate, difference of grasses, etc., etc., are named, but the real reason why this is commercially impossible, and farming, properly so called, is becoming a lost art in England (mere meadow or prairie grazing gradually superseding it) is not named in any part of the discussion that I have read.

I refer to the cause which is abolishing the English dairy, which drives us to the commercial absurdity of importing fragile eggs from France, Italy, Spain, etc., apples from the other side of the Atlantic, tame house-fed rabbits from Belgium, and so on, with all other agricultural products which are precisely those we are *naturally* best able to produce at home; I mean *those demanding a small area of land and a proportionately large amount of capital and labor.* A poultry or rabbit farm, acre for acre, demands fully ten times the capital, ten times the labor, and yields ten times the produce obtained by our big-field beef and mutton graziers.

The scientific and economic merits of ensilage are probably all that is claimed for it, and it is especially adapted for our uncertain haymaking climate, but what farmer who is merely a lodger on the land, holding it as an annual tenant-at-will or under a stinted beggarly lease of 21 years, would expend his capital in building a costly *silo,* which becomes by our feudal laws and usages the absolute property of the landlord?

Our tenant farmers employ the latest and best achievements of engineering science in the form of implements, but take care that they shall be *upon wheels*, or otherwise non-fixtures, and use rich chemically prepared manures, provided they are not permanent, while they abstain from improvements which involve any serious outlay in the form of fixtures on the land. Those who lecture them about their want of enterprise should always remember that their condition is merely a form of feudal serfdom, tempered by the possession of capital, and that all their agricultural operations are influenced by a continual struggle to prevent their capital from falling into the hands of the feudal lord. Anybody who has ever read an ordinary form of English farm-lease, with its prohibitions concerning the sale of hay and straw, and restrictions to "four-course," or other mode of cultivation, must see the hopelessness of any development of British agriculture comparable to that of British commerce and manufactures.

Imagine the condition of a London shopkeeper or Midland manufacturer holding his business premises as a yearly tenant, liable at six months' notice to quit, with confiscation of all his business fixtures.

THE FRACTURE OF COMETS.

The view of the constitution of comets expounded in one of my notes of April last, viz., that they are meteoric systems consisting of a central mass, or masses, round which a multitude of minor bodies are revolving like satellites around their primary, is strongly confirmed by the curious proceedings of the present comet, which proceedings also justify my last note of last month pointing out the omission of our astronomers, who have neglected the positive and irregular repulsive action of the sun upon comets, that, like the great comets of 1843, 1880, and 1882, come within a few hundred thousand miles of the visible solar surface.

The solar prominences are stupendous eruptions from the sun, consisting, as the spectroscope demonstrates, of hydrogen flames and incandescent metallic vapors ejected with furious violence to visible distances ranging from ten or twenty to above three hundred thousand miles, but this flame shown by the spectroscope is but the flash of the gun, the actual ejection proceeding vastly farther, far beyond the limits of the corona, as described in last month's notes. These eruptions are so abundant that Secchi alone observed and recorded 2767 in one year (1871). Speaking generally, the sun is never free from them, and they proceed from all parts of the sun, but most abundantly from the sun-spot zones.

A system of meteoric bodies such as I suppose to form a comet (I mean the comet as it exists in space before the generation of its tail, which is only formed as it approaches the sun) could not approach so near to the sun as did the present comet at perihelion, without encountering more or less of these furious blasts the flash of some of which have been seen to move with a measurable mean velocity of above 300 miles per second, and a probable maximum velocity sufficient to eject solid matter beyond the reclaiming grasp of solar gravitation.

It is evident that such a meteoric system as I suppose to constitute a comet would, in the course of a rapid perihelion flight crossing these outblasts, be liable to various degrees of ejection in different parts, that would disturb its original structure by blowing some of its constituents out of their orbits, or even quite away from the control of the feeble gravitation of the general meteoric mass, and thus effecting a rupture of the comet.

Now such a disintegration or dispersion of the present comet has been actually observed. Several able observers have described a breaking of the head of this comet shortly after its perihelion passage. Commander Sampson's observations with the great 26-inch equatorial telescope of the Washington Naval Observatory are very explicit. On October 25 he saw the nucleus as a single well-defined globular body. On November 3, with the same telescope, he saw a triple nucleus, due to the formation of two additional minor bodies. These were more distinctly seen on November 6. Mr. W. R. Brooks, of New York, saw a detached fragment of the comet which afterwards faded out of view. Professor Schmidt observed another and similar fragment which has likewise disappeared.

All these observations indicate disruption due to some disturbing force, acting with different degrees of violence upon different portions of the comet.

Minor disturbances of this kind will, I think, account for the trail of meteoric bodies which Schiaparelli has shown to follow the paths of other comets. A great disturbance might give quite a new orbit to the meteoric fragments.

These considerations suggest another and a curious view of the question of possible cometary collision with the sun, viz., that a comet might be traveling in such an orbit as to make it mathematically due to plunge obliquely beneath the solar surface at its next perihelion; but on its approach to the surface of the sun it might encounter so violent an outrush of solar-prominence matter as to drive it bodily out of its course, and avert the threatened peril to its existence.

THE ORIGIN OF COMETS.

We read in story-books of uncomfortable people who have cherished a guilty secret in their bosoms, that it has "gnawed their vitals," until at last they have carried it to the grave. I have such a secret that does the gnawing business whenever I write or speak of comets, concerning the origin of which I am guilty of an hypothesis that has hitherto been cherished as aforesaid from the very shame of adding another to an already exaggerated heap of speculations on celestial physics.

It assumes, in the first place, that all the other suns which we see as stars are constituted like our own sun; that they eject great eruptions similar to the prominences above described, and even of vastly greater magnitude, as in the case of the flashing stars that have excited so much wonderment among astronomers, but which I regard simply as suns like ours, subject, like ours, to periodic maximum and minimum activities, but of greater magnitude.

If such is the case, some of the prominence matter or vaporous constituents of these suns must be ejected with much greater proportional violence than are those from our sun. But those from our sun have been proved to rush out on some occasions with a velocity so great that the solar gravitation cannot bring them back. If such is ever the case with the explosions of our sun, it must be of frequent occurrence with the greater explosions of certain stars, and therefore vast quantities of meteoric matter are continually ejected into space, and traveling there until they come within the gravitation domain of some other sun like ours, when they will necessarily be bent into such orbits as those of comets.

But what will be the nature of this meteoric matter?

If from our sun, it would be a multitude of metallic hailstones, due to the condensation of the metallic vapor by cooling as it leaves the sun, and such meteoric hail would correspond to the meteoric stones that fall upon our earth, and which, for reasons stated in "The Fuel of the Sun," I believe to be of solar origin. Besides these, there would be ice-hail, such as Schevedorf claims to be meteoric.

A star mainly composed of hydrogen and carbon, or densely enveloped in these gases (as the spectroscope indicates to be the case in some of these flashing stars), would eject hydrocarbon vapors, condensible by cooling into solids similar to those we obtain by the condensation of terrestrial hydrocarbon vapors (paraffin, camphor, turpentine, and all the essential oils, for example), and thus we should have the meteoric systems composed of these particles circulating about their own common centre of mass as above stated, and displaying the spectrum which Dr. Huggins has found common to comets.

If this is correct, the present comet comes from a sun that contains metallic sodium in addition to the hydrocarbons, as the spectrum of this metal was seen when this comet was near enough to the sun to render its vapor incandescent.

DEEP DOWN:

A TALE OF THE CORNISH MINES.

CHAPTER I.

BEGINS THE STORY WITH A PECULIAR MEETING.

Necessity is the mother of Invention. This is undoubtedly true, but it is equally true that Invention is not the only member of Necessity's large family. Change of scene and circumstance are also among her children. It was necessity that gave birth to the resolve to travel to the end of the earth—of English earth at all events—in search of fortune, which swelled the bosom of yonder tall well-favoured youth, who, seated uncomfortably on the top of that clumsy public conveyance, drives up Market-Jew Street in the ancient town of Penzance. Yes, necessity—stern necessity, as she is sometimes called—drove that youth into Cornwall, and thus was the originating cause of that wonderful series of events which ultimately led to his attaining—but hold! Let us begin at the beginning.

It was a beautiful morning in June, in that period of the world's history which is ambiguously styled "Once-upon-a-time," when the "Kittereen"—the clumsy vehicle above referred to—rumbled up to the Star Inn and stopped there. The tall well-favoured youth leaped at once to the ground, and entered the inn with the air of a man who owned at least the half of the county, although his much-worn grey shooting costume and single unpretentious portmanteau did not indicate either unusual wealth or exalted station.

In an off-hand hearty way, he announced to landlord, waiters, chambermaids, and hangers-on, to all, indeed, who might choose to listen, that the weather was glorious, that coaches of all kinds, especially Kittereens, were detestable machines of torture, and that he meant to perform the remainder of his journey on foot.

He inquired the way to the town of St. Just, ordered his luggage to be forwarded by coach or cart, and, with nothing but a stout oaken cudgel to encumber him, set out on his walk of about seven miles, with the determination of compensating himself for previous hours of forced inaction and constraint by ignoring roads and crossing the country like an Irish fox-hunter.

Acting on the presumptuous belief that he could find his way to any part of the world with the smallest amount of direction, he naturally missed the right road at the outset, and instead of taking the road to St. Just, pursued that which leads to the Land's End.

The youth, as we have observed, was well-favoured. Tall, broad-shouldered, deep-chested, and athletic, with an active step, erect gait, and clear laughing eye, he was one whom a recruiting-sergeant in the Guards would have looked upon with a covetous sigh. Smooth fair cheeks and chin told that boyhood was scarce out of sight behind, and an undeniable *something* on the upper lip declared that manhood was not far in advance.

Like most people in what may be termed an uncertain stage of existence, our hero exhibited a variety of apparent contradictions. His great size and muscular strength and deep bass voice were those of a man, while the smooth skin, the soft curling hair, and the rollicking gladsome look were all indicative of the boy. His countenance, too, might have perplexed a fortune-teller. Sometimes it was grave almost to sternness, at other times it sparkled with delight, exhibiting now an expression that would have befitted a sage on whose decisions hung the fate of kingdoms, and anon displaying a dash of mischief worthy of the wildest boy in a village school.

Some of the youth's varied, not to say extravagant, actions and expressions, were perhaps due to the exhilarating brilliancy of the morning, or to the appearance of those splendid castles which his mind was actively engaged in building in the air.

The country through which he travelled was at first varied with trees and bushes clothed in rich foliage, but soon its aspect changed, and ere long he pursued a path which led over a wide extent of wild moorland covered with purple heath and gorse in golden-yellow bloom. The ground, too, became so rough, that the youth was fain to confine himself to the high road, but being of an explorative disposition, he quickly diverged into the lanes, which in that part of Cornwall were, and still are, sufficiently serpentine and intricate to mislead a more experienced traveller. It soon began to dawn upon the youth's mind that he was wandering in a wrong direction, and when he suddenly discovered a solitary cottage on the right hand, which he had previously observed on the left, he made up his mind to sacrifice his independence and condescend to ask for guidance.

Lightly leaping a wall with this intent, he crossed two fields, and stooped as he looked in at the low doorway of the cottage, from the interior of which there issued the loud cries of a child either in great pain or passion.

A sturdy little boy seated on a stool, and roaring like a young bull, while an elderly woman tried tc comfort him, was the sight which met his gaze.

" Can you show me the road to St. Just?" inquired our adventurer.

" St. Just, sur?" said the woman, stepping out in front of the door, "why, you 're on the way to St. Buryan, sure. Ef you do keep on the right of the hill over theere, you 'll see the St. Just road."

A yell of unparalleled ferocity issued at this moment from the cottage, and it was found that the noisy urchin within, overcome by curiosity, had risen to ascertain who the stranger outside could be, and had been arrested by a pang of agony.

" Aw dear, aw dear, my poor booy," exclaimed the woman, endeavouring gently to press the boy down again on the stool, amid furious roaring.

" What 's wrong with him?" asked our traveller, entering the apartment.

" He 's tumbled off the wall, dear booy, an' semen to me he 's scat un shoulder very bad."

" Let me have a look at him," said the youth, sitting down on the edge of a bed which stood at one end of the room, and drawing the child between his knees. " Come, little man, don't shout so loud; I 'll put it all right for you; let me feel your shoulder."

To judge from the immediate result, the young man seemed to put it all wrong instead of "all right," for his somewhat rough manipulation of the boy's shoulder produced such a torrent of screams that the pitying woman had much ado to restrain herself from rushing to the rescue.

"Ah!" exclaimed the youth in grey, releasing his victim; "I thought so; he has broken his collar-bone, my good woman; not a serious matter, by any means, but it will worry him for some time to come. Have you got anything to make a bandage of?"

"Sur?" said the woman.

"Have you a bit of rag—an old shirt or apron?—anything will do."

The woman promptly produced a cotton shirt, which the youth tore up into long strips. Making a pad of one of these, he placed it under the boy's arm-pit despite of sobs and resistance. This pad acted as a fulcrum on which the arm rested as a lever. Pressing the elbow close to the boy's side he thus forced the shoulder outwards, and, with his left hand, set the bone with its two broken ends together. To secure it in this position he bound the arm pretty firmly to the boy's body, so that he could not move a muscle of the left arm or shoulder.

"There," said the youth, assisting his patient to put on his shirt, "that will keep all straight. You must not on any account remove the bandage for some weeks."

"How long, sur?" exclaimed the woman in surprise.

"For some weeks; but that will depend on how the little fellow gets on. He may go about and use his right arm as he pleases, but no more climbing on walls for some time to come. Do you hear, little man?"

The urchin, whose pain was somewhat relieved, and who had moderated down to an occasional deep sob, said "Iss."

"You're a doctor, sur, I think?" said the woman.

"Yes, I am, and I'll come to see you again, so be careful to attend to my directions. Good morning."

"Good mornin', sur, an' thank 'ee!" exclaimed the grateful dame as the youth left the house, and, leaping the low enclosure in front of it, sped over the moor in the direction which had been pointed out to him.

His resolution to ignore roads cost our traveller more trouble than he had anticipated, for the moor was very rugged, the brambles vexatious, and the spines of the gorse uncommonly sharp. Impediments of every kind were more numerous than he had been accustomed to meet with even on the heath-clad hills of Scotland, with which—although "the land of the mountain and the flood" was not that of his birth—he had from childhood been familiar.

After a good deal of vigorous leaping and resolute scrambling, he reached one of those peculiar Cornish lanes which are so deeply sunk in the ground, and edged with such high solid walls, that the wayfarer cannot in many places see the nature of the country through which he is passing. The point at which he reached the lane was so overgrown with gorse and brambles that it was necessary to search for a passage through them. This not being readily found, he gave way to the impetuosity of his disposition, stepped back a few paces, cleared the obstacles with a light bound, and alighted on the edge of the bank, which gave way under his weight, and he descended into the lane in a shower of stones and dust, landing on his feet more by chance than by dexterity.

A shout of indignation greeted the traveller, and, turning abruptly round, he beheld a stout old gentleman stamping with rage, covered from head to foot with dust, and sputtering out epithets of opprobrium on the hapless wight who had thus unintentionally bespattered him.

"Ugh! hah! you young jackanapes—you blind dumbledory—ugh! What mean you by galloping over the country thus like a wild ass—eh?"

A fit of coughing here interrupted the choleric old gentleman, in the midst of which our hero, with much humility of demeanour, many apologies, and protestations of innocence of intention to injure, picked up the old gentleman's hat, assisted him to brush his clothes with a bunch of ferns, and in various other ways sought to pacify him.

The old man grumbled a good deal at first, but was finally so far mollified as to say less testily, while he put on his hat, "I warrant me, young man, you are come on some wild-goose chase to this cut-o'-the-way region of the land in search o' the picturesque—eh?—a dauber on canvas?"

"No, sir," replied the youth, "I profess not to wield the pencil or brush, although I admit to having made feeble efforts as an amateur. The scalpel is more to my taste, and my object in coming here is to visit a relative. I am on my way to St. Just; but, having wandered somewhat out of my way, have been obliged to strike into bypaths, as you see."

"As I *see*, young man!—yes, and as I *feel*," replied the old gentleman, with some remains of asperity.

"I have already expressed regret for the mischance that has befallen you," said the youth in grey somewhat sternly, for his impulsive spirit fired a little at the continued ill-humour of the old gentleman. "Perhaps you will return good for evil by pointing out the way to St. Just. May I venture to ask this favour of you?"

"You may venture, and you *have* ventured; and it is my belief, young man, that you'll venture many a thing before this world has done with you; however, as you are a stranger in these parts, and have expressed due penitence for your misdeed, though I more than half doubt your sincerity, I can do no less than point out the road to St. Just, whither I will accompany you at least part of the way; and, young sir, as you have taken pretty free liberty with *me* this morning, may I take the liberty of asking *you* the name of your relative in St. Just? I am well acquainted with most of the inhabitants of that town."

"Certainly," replied the youth. "The gentleman whom I am going to visit is my uncle. His name is Donnithorne."

"What! Tom Donnithorne?" exclaimed the old gentleman, in a tone of surprise, as he darted a keen glance from under his bushy eyebrows at his companion. "Hah! then from that fact I gather that you are Oliver Trembath, the young doctor whom he has been expecting the last day or two. H'm—so old Tom Donnithorne is your uncle, is he?"

The youth in grey did not relish the free and easy not to say patronizing, tone of his companion, and felt inclined to give a sharp answer, but he restrained his feelings and replied—

"He is, and you are correct in your supposition regarding myself. Do you happen to know my uncle personally?"

"Know him personally!" cried the old gentleman with a sardonic laugh; "O yes, I know him intimately—intimately; some people say he's a very good fellow."

"I am glad to hear that, for to say truth—"

He paused abruptly.

"Ha! I suppose you were going to say that you have heard a different account of him—eh?"

"Well, I *was* going to observe," replied Oliver, with a laugh, "that my uncle is rather a wild man for his years—addicted to smuggling, I am told, and somewhat given to the bottle; but it is well known that tattlers give false reports, and I am delighted to hear that the old boy is not such a bad fellow after all."

"Humph!" ejaculated the other. "Then you have never seen him, I suppose?"

"No, never; although I am a Cornishman I have seen little of my native county, having left it when a little boy—before my uncle came to live in this part of the country."

"H'm—well, young man, I would advise you to beware of that same uncle of yours."

"How!" exclaimed the youth in surprise; "did you not tell me just now that he is a very good fellow?"

"No, sir, I did not. I told you that *some* people say he is a very good fellow, but for myself I think him an uncommonly bad man, a man who has done me great injury in his day—"

"It grieves me to hear you say so," interrupted Oliver, whose ire was again roused by the tone and manner of his companion.

"A decidedly bad man," continued the old gentleman, not noticing the interruption, "a thorough rascal, a smuggler, and a drunkard, and—"

"Hold, sir," cried the youth sternly, as he stopped and faced the old gentleman, "remember that you speak of *my* relative. Had you been a younger man, sir—"

Again the youth paused abruptly.

"Go on, sir," said the old gentleman ironically; "you would have pommelled me to a jelly with your cudgel, I suppose; is that it?—acting somewhat in the spirit of your kinsman, that same smuggling and tippling old scoundrel, who—"

"Enough, sir," interrupted the young man angrily; "we part company here."

So saying, he vaulted over the wall that separated he road from the moor, and hurried away.

"Take the first turn to the left, and keep straight on, else you'll lose yourself aga-a-a-in," roared the old gentleman, "and my compliments to the rascally old smugg-le-e-r-r!"

"The old scoundrel!" muttered the youth as he hurried away.

"The young puppy!" growled the old gentleman as he jogged along. "Given to smuggling and the bottle indeed—humph! the excitable jackanapes! but I've given him a turn in the wrong direction that will cool his blood somewhat, and give me leisure to cool mine too before we meet again."

Here the old gentleman's red countenance relaxed into a broad grin, and he chuckled a good deal, in the midst of a running commentary on the conduct and appearance of his late companion, from the disjointed sentences of which it might have been gathered that although his introduction to the young doctor had been unfortunate, and the succeeding intercourse stormy, his opinion of him was not altogether unfavourable.

CHAPTER II.

SHOWS WHAT ASTONISHING RESULTS MAY FOLLOW FROM TAKING THE WRONG ROAD.

BEFORE Oliver Trembath had advanced half a mile on his path, he had cooled sufficiently to experience some regret at having been so quick to take offence at one who, being evidently an eccentric character, should not, he thought, have been broken with so summarily. Regrets, however, had come too late, so he endeavoured to shake off the disagreeable feelings that depressed him, and, the more effectually to accomplish this, burst forth into a bravura song with so much emphasis, as utterly to drown, and no doubt to confound, two larks, which, up to that time, had been pouring their melodious souls out of their little bodies in the bright blue sky above.

Presently he came to a part of the moor where two roads diverged—one to the right and the other to the left. Recalling the shout of advice which the old gentleman had given him at parting, he took that which led to the left, and was gratified, on gaining an eminence a short distance in advance, to see in the far distance a square turret, which he concluded was that of the church of St. Just.

Keeping this turret in view, the youth stepped out so vigorously that he soon reached the small town that clustered round the church, and going up to the first man he met, said, "This is the town of St. Just, I suppose, is it not?"

"No, et is'n ; thee's come the wrang road, sur," replied the rustic. "This es Sennen church-town. St. Just es up over th' hill theere."

Oliver Trembath's first feeling was one of surprise; this was followed by annoyance, which quickly degenerated into anger as it flashed into his mind that the old gentleman might possibly have led him wrong on purpose.

"How far is it to St. Just?" he inquired.

"'Bout six miles, sur."

"Then I suppose I am not far from the Land's End?" said Oliver after a pause.

"No, not fur," replied the man. "Et do lie straight before 'ee."

Thanking the man, Oliver started off at a smart pace, resolving, before proceeding to St. Just, to visit this extreme western point of England,—a visit to which he had often looked forward with pleasant anticipation.

During the last hour of his walk, the sun had been obscured by clouds, but, just as he approached the cliffs, the clouds separated, and a golden flood rushed over the broad Atlantic, which now lay spread out before him in all its wide majesty as far as the eye could see.

"A good omen!" cried the youth with a shout, as he hurried towards the shore, intending to fling off his garments and bathe in the mighty ocean, which, from the place where he first beheld it, appeared to be smooth and still as a mill-pond. But Oliver was compelled to restrain his ardour, for on nearing the sea he found that he stood on the summit of high cliffs, beyond which the Land's End stretched in a succession of broken masses of granite, so chafed and shattered by the action of the sea, and so curiously split, as to resemble basaltic columns. To reach the outermost of those weather-worn sentinels of Old England, required some caution on the part of our traveller, even although well used to scaling the rocky heights of Scottish mountains, and when he did at last plant his foot on the veritable Land's End, he found that it was a precipice apparently sixty feet high, which descended perpendicularly into deep water. His meditated bathe was therefore an impossibility, for those glassy undulations, which appeared so harmless at a distance, gathered slow and gradual height as they approached the land, and at last, assuming the form of majestic waves, flung themselves with a grand roar on the stern cliffs which they have battered so long in vain, and round which —always repulsed but never conquered —they seethed in milky foam.

With glistening eye, and heaving breast, and mantling colour, the young doctor stood long and motionless on this extreme point of land—absorbed in admiration of the glorious scene before him. Often had he beheld the sea in the firths and estuaries of the North, but never till now had he conceived the grandeur of the great Atlantic. It seemed to him as if the waves of those inland seas, when tossed by wild storms, were but rough miniature copies of the huge billows which arose before him, without apparent cause, and, advancing without rush or agitation, fell successively with solemn roar at his feet, awakening irresistibly within him deep and new thoughts of the Almighty Creator of earth and sea.

For many minutes he stood entranced, his mind wandering in a species of calm delight over the grand scene, but incapable of fixing itself definitely on any special feature—now sweeping out to where the Scilly Isles could be seen resting on the liquid horizon, anon following the flight of circling sea-gulls, or busy counting the innumerable ships and boats that rested on the sea, but ever and anon recurring, as if under the influence of fascination, to that rich turmoil of foam which boiled.

leaped, and churned, around, beneath, and above the mighty breakers.

Awaking at last from his trance, Oliver tore himself from the spot, and hastened away to seek the nearest strip of sand where he might throw off his clothes and plunge into the boiling surf.

He proceeded in a southerly direction, impatiently expecting at every step to discover some spot suitable for his purpose, but he had taken a long and rapid walk before he found a break in these wild cliffs which afforded him the opportunity of descending to the water's edge. Here, on a narrow strip of sand, he undressed and leaped into the waves.

Well was it for Oliver that day that he had been trained in all manly exercises, that his "wind" was good, that his muscles were hard, his nerves well strung, and, above all, that in earliest youth he had learned to swim.

Misjudging, in his ignorance, the tremendous power of the surf into which he sprang, and daring to recklessness in the conscious possession of unusual strength and courage, he did not pause to look or consider, but at once struck out to sea. He was soon beyond the influence of the breaking waves, and for some time sported in the full enjoyment of the briny Atlantic waters. Then turning towards the shore he swam in and was speedily tossing among the breakers. As he neared the sandy beach and felt the full power of the water on his partially exhausted frame, he experienced a slight feeling of anxiety, for the thunder of each wave as it fell, and rushed up before him in seething foam, seemed to indicate a degree of force which he had not realized in his first vigorous plunge into the sea. A moment more and a wave caught him in its curling crest, and swept him onwards. For the first time in his life, Oliver Trembath's massive strength was of no avail to him. He felt like a helpless infant. In another instant the breaker fell and swept him with irresistible violence up the beach amid a turmoil of hissing foam. No sooner did he touch the ground than he sprang to his feet, and staggered forward a few paces, but the returning rush of water swept sand and stones from beneath his feet, carried his legs from under him, and hurled him back into the hollow of the succeeding wave, which again rolled him on the sand.

Although somewhat stunned, Oliver did not lose consciousness or self-possession. He now fully realized the extreme danger of his position, and the thought flashed through his brain that, at the farthest, his fate must be decided in two or three minutes. Acting on a brave spirit, this thought nerved him to desperate effort. The instant he could plant his feet firmly he bounded forwards, and then, before the backward rush of water had gathered strength, fell on his knees, and dug his fingers and toes deep into the sand. Had the grasp been on something firm he could easily have held on, but the treacherous sand crumbled out of his grasp, and a second time he was carried back into the sea.

The next time he was cast on the beach he felt that his strength was failing; he staggered forward as soon as he touched bottom, with all the energy of one who avails himself of his last chance, but the angry water was too strong for him; feeling that he was being overpowered, he cast his arms up in the air, and gave utterance to a loud cry. It was not like a cry of despair, but sounded more like what one might suppose would be the shout of a brave soldier when compelled to give way—fighting—before the might of overwhelming force. At that moment a hand caught the young man's wrist, and held it for a few seconds in a powerful grasp. The wave retreated, a staggering effort followed, and the next moment Oliver stood panting on the beach grasping the rough hand of his deliverer.

"Semen to me you was pretty nigh gone, sur," said the man, who had come thus opportunely to the rescue, as he wrung the sea-water from his garments.

He was a man of middle height, but of extremely powerful frame, and was habited in the garb of a fisherman.

"Truly I had been gone altogether but for your timely assistance; may God reward you for it!" said Oliver earnestly.

"Well, I don't think you would be so ready to thank me if you did knaw I had half made up my mind to lev 'ee go."

Oliver looked at the man in some surprise, for he spoke gruffly, almost angrily, and was evidently in earnest.

"You are jesting," said he incredulously.

"Jestin'; no I ain't, maister. Do 'ee see the boat out over?" he said, pointing to a small craft full of men which was being rowed swiftly round a point not more than half a mile distant; "the villains are after me. They might as well have tried to kitch a cunger by the tail as nab Jim Cuttance in one of his dens, if he hadn't bin forced by the softness of his 'art to pull a young fool out o' the say. You'll have to help me to fight, lad, as I 've saved your life. Come, follow me to the cave."

"But—my clothes—" said Oliver, glancing round him in search of his garments.

"They 're all safe up here; come along, sur, an' look sharp."

At any other time, and in other circumstances, Oliver Trembath's fiery spirit would have resented the tone and manner of this man's address, but the feeling that he owed his life to him, and that in some way he appeared to be the innocent cause of bringing misfortune on him, induced him to restrain his feelings and obey without question the mandate of his rescuer. Jim Cuttance led the way to a cave in the rugged cliffs, the low entrance to which was concealed by a huge mass of granite. The moment they entered, several voices burst forth in abuse of the fisherman for his folly in exposing himself, but the latter only replied with a sarcastic laugh, and advised his comrades to get ready for action, for he had been seen by the enemy, who would be down on them directly. At the same time he pointed to Oliver's clothes, which lay in a recess in the side of the cavern.

The youth dressed himself rapidly, and, while thus engaged, observed that there were five men in the cavern, besides his guide, with whom they retired into the farthest recess of the place, and entered into animated and apparently angry, though low-toned, conversation. At length their leader, for such he evidently was, swung away from them, exclaiming, with a laugh—"Well, well, he's a good recruit, and if he should peach on we—us can—."

He concluded the sentence with a significant grunt.

"Now, sur," he said, advancing with his comrade towards Oliver, who was completing his toilet, "they'll be here in ten minutes, an' it is expected that you will lend we a hand. Here's a weapon for you."

So saying, he handed a large pistol to Oliver, who received it with some hesitation.

"I trust that your cause is a good one," he said. "You cannot expect me to fight for you, even though I am indebted to you for my life, without knowing against whom I fight, and why."

At this a tall thick-set man suddenly cocked his pistol, and uttering a fierce oath swore that if the stranger would not fight, he'd shoot him through the head.

"Silence, Joe Tonkin!" cried Jim Cuttance, in a tone that at once subdued the man.

Oliver, whose eyes had flashed like those of a tiger, drew himself up, and said—"Look at me, lads; I have no desire to boast of what I can or will do, but I assure you it would be as easy to turn back the rising tide as to force me to fight against my will—except, indeed, with yourselves. As I have said, I owe my life to your leader, and apparently have been the innocent means of drawing his enemies upon him. Gratitude tells me to help him if I can, and help him I will if the cause be not a bad one."

"Well spoken, sur," said the leader, with an approving nod; "see to the weapons, Maggot, and I'll explain it all to the gentleman."

So saying, he took Oliver aside, told him hurriedly that the men who were expected to attack them were fishermen belonging to a neighbouring cove, whose mackerel nets had been accidentally cut by his boat some weeks ago, and who were bent on revenge, not believing that the thing had been done by accident.

"But surely you don't mean to use fire-arms against them in such a quarrel?" said Oliver.

A sort of humorous smile crossed the swarthy countenance of the man as he replied—

"They will use pistols against we."

"Be that as it may," said Oliver; "I will never consent to risk taking the life of a countryman in such a cause."

"But you can't fight without a weapon," said the man; "and sure, if 'ee don't shut them they'll shut you."

"No matter, I'll take my chance," said Oliver; "my good cudgel would have served me well enough, but it seems to have been swept away by the sea; here, however, is a weapon that will suit me admirably," he added, picking up a heavy piece of driftwood that lay at his feet.

"Well, if you scat their heads with that, they won't want powder and lead," observed the other with a grin, as he rose and returned to the entrance of the cave, where he warned his comrades to keep as quiet as mice.

The boat which had caused so much angry discussion among the men of the cave had by this time neared the beach, and one of the crew stood up in the bow to guide her into the narrow cove, which formed but a slight protection, even in calm weather, against the violence of that surf which never ceases to grind at the hard rocks of West Cornwall. At length they effected a landing, and the crew, consisting of nine men armed with pistols and cutlasses, hurried up to the cliffs and searched for the entrance to the cavern.

While the events which have been related were taking place, the shades of evening had been gradually creeping over land and sea, and the light was at that time scarcely sufficient to permit of things being distinguished clearly beyond a few yards. The men in the cavern hid themselves in the dark recesses on each side of the entrance, ready for the approaching struggle.

Oliver crouched beside his rescuer with the piece of drift-wood by his side. Turning suddenly to his companion, he said, in an almost inaudible whisper—

"Friend, it did not occur to me before, but the men we are about to fight with will recognise me again if we should ever chance to meet; could I not manage to disguise myself in some way?"

"If you get shut," replied his companion in the same low tone, "it won't matter much; but see here --shut your eyes."

Without further remark the man took a handful of wet earth and smeared it over Oliver's face, then, clapping his own "sou'-wester" on his head, he said, with a soft chuckle,—"There, your own mother wouldn't knaw 'ee!"

Just then footsteps were heard approaching, and the shadow of a man was seen to rest for a moment on the gravel without. The mouth of the cave was so well hidden, however, that he failed to observe it, and passed on, followed by several of his comrades. Suddenly one of them stopped and said—

"Hold on, lads, it can't be far off, I'm sartin' sure; I seed 'em disappear hereabouts."

"You're right," cried Jim Cuttance, with a fierce roar, as he rushed from the cavern and fired full at the man who had spoken. The others followed, and a volley of shots succeeded, while shouts of defiance and anger burst forth on all sides. Oliver sprang out at the same moment with the leader, and rushed on one of the boat's crew with such violence, that his foot slipped on a piece of sea-weed and precipitated him to the ground at the man's feet; the other, having sprung forward to meet him, was unable to check himself, tripped over his shoulders and fell on the top of him. The man named Maggot having been in full career close behind Oliver, tumbled over both, followed by another man named John Cock. The others observing them down, rushed with a shout to the rescue, just as Oliver, making a superhuman effort, flung the two men off his back and leaped to his feet. Maggot and the boatman also sprang up, and the latter turned and made for the boat at full speed, seeing that his comrades, overcome by the suddenness of the onset, were in retreat, fighting as they went.

All of them succeeded in getting into the boat unharmed, and were in the act of pushing off, when Jim Cuttance, burning with indignation, leaped into the water, grasped the bow of the boat, and was about to plunge his cutlass into the back of the man nearest him, when he was seized by a strong hand from behind and held back. Next moment the boat was beyond his reach.

Turning round fiercely, the man saw that it was Oliver Trembath who had interfered. He uttered a terrible oath and sprang on him like a tiger; Oliver stood firm, parried with the piece of driftwood the savage cut which was made at his head, and with his clenched left hand hit his opponent such a blow on the chest as laid him flat on the sand. The man sprang up in an instant, but instead of renewing the attack, to Oliver's surprise he came forward and held out his hand, which the youth was not unwilling to grasp.

"Thank 'ee, sur," he said, somewhat sternly, "you 've done me a sarvice; you 've prevented me committin' two murders, an' taught me a lesson I never knaw'd afore,—that Jim Cuttance an't invulnerable. I don't mind the blow, sur—not I. It wor gov'n in feer fight, an' I was wrang."

"I'm glad to find that you view the matter in that light," said Oliver, with a smile, "and, truly, the blow was given in self-defence by one who will never forget that he owes you his life."

A groan here turned the attention of the party to one of their number who had seated himself on a rock during the foregoing dialogue.

"What! not hurt, are 'ee, Dan?" said his leader, going towards him.

To this Dan replied with another groan, and placed his hand on his hip.

His comrades crowded round him, and, finding that he was wounded and suffering great pain, raised him in their arms and bore him into the cavern, where they laid him on the ground, and, lighting a candle, proceeded to examine him.

"You had better let me look at him, lads," said Oliver, pushing the men gently aside, "I am a surgeon."

They gave place at once, and Oliver soon found that the man had received a pistol-ball in his thigh. Fortunately it had been turned aside in its course, and lay only a little way beneath the skin, so that it was easily extracted by means of a pen-knife.

"Now, friends," said Oliver, after completing the dressing of the wound, "before I met with you I had missed my way while travelling to St. Just. Will one of you direct me to the right road, and I shall bid you good-night, as I think you have no further need of my services."

The men looked at their leader, whom they evidently expected to be their spokesman.

"Well, sur, you have rendered we some help this hevenin', both in the way o' pickin' out the ball an' helpin' to break skulls as well as preventin' worse, so we can do no less than show 'ee the road; but hark 'ee, sur," here the man became very impressive, "ef you do chance to come across any of us in your travels, you had better not knaw us, 'xcept in an or'nary way, d'ye understand? an' us will do the same by thee."

"Of course I will act as you wish," said Oliver, with a smile, "although I do not see why we should be ashamed of this affair, seeing that we were the party attacked. There is only one person to whom I would wish to explain the reason of my not appearing sooner, because he will probably know of the arrival in Penzance this morning of the conveyance that brought me to Cornwall."

"And who may that be?" demanded Jim Cuttance.

"My uncle, Thomas Donnithorne of St. Just," said Oliver.

"Whew!" whistled the fisherman in surprise, while all the others burst into a hearty fit of laughter.

"Why do you laugh?" asked Oliver.

"Oh, never mind, sur, it's all right," said the man with a chuckle. "Iss, you may tell Thomas Donnithorne; there won't be no harm in tellin' he—O dear no!"

Again the men laughed loud and long, and Oliver felt his powers of forbearance giving way, when Cuttance said to him: "An' you may tell all his friends too, for they're the right sort. Come now, Maggot here will show 'ee the way up to St. Just."

So saying, the stout fisherman conducted the young surgeon to the mouth of the cavern, and shaking hands with him left him to the guidance of the man named Maggot, who led him through several lanes, until he reached the high road between Sennen church-town and St. Just. Here he paused; told his companion to proceed straight on for about four miles or so, when he would reach the town, and bade him good-night.

"And mind 'ee, don't go off the road, sur," shouted Maggot, a few seconds after the young man had left him, "if 'ee don't want to fall down a shaft and scat your skull."

Oliver, not having any desire to scat his skull, whatever that might be, assured the man that he would keep to the road carefully.

The moon shone clear in a cloudless sky, covering the wide moor and the broad Atlantic with a flood of silver light, and rendering the road quite distinct, so that our traveller experienced no further difficulty in pursuing his way. He hurried forward at a rapid pace, yet could not resist the temptation to pause frequently and gaze in admiration on the scene of desolate grandeur around him. On such occasions he found it difficult to believe that the stirring events of the last few hours were real. Indeed, if it had not been that there were certain uneasy portions of his frame—the result of his recent encounter on the beach—which afforded constant and convincing evidence that he was awake, he would have been tempted to believe that the adventures of that day were nothing more than a vivid dream.

CHAPTER III.

INTRODUCES A FEW MORE CHARACTERS AND HOMELY INCIDENTS.

It was late when our hero entered the little town of St. Just, and inquired for the residence of his uncle, Thomas Donnithorne. He was directed to one of the most respectable of the group of old houses that stood close to the venerable parish church from which St. Just derives its title of "Church-town."

He tapped at the door, which was opened by an elderly female.

"Does Mr. Thomas Donnithorne live here?" asked Oliver.

"Iss, sur, he do," answered the woman; "walk in, sur."

She ushered him into a small parlour, in which was seated a pretty little dark-eyed rosy-cheeked girl, still in, or only just out of, her teens. Oliver was so taken aback by the unexpected sight, that he stood gazing for a moment or two in rather stupid silence.

"Your name is Oliver Trembath, I presume," said the girl, rising and laying down the piece of needlework with which she was occupied.

"It is," replied Oliver, in some surprise, as he blundered out an apology for his rudeness.

"Pray sit down, sir," said the girl; "we have been expecting you for some time, and my uncle told me to act the part of hostess till his return."

"Your uncle!" exclaimed Oliver, whose self-possession, not to say impudence, returned immediately; "if Thomas Donnithorne be indeed your uncle, then, fair maid, you and I must needs be cousins, the which, I confess, fills me with satisfaction and also with somewhat of surprise, for up to this hour I have been ignorant of my good fortune in being related to so—so—."

"I made a mistake, sir," said the girl, interrupting a speech which was evidently verging towards impropriety, "in calling Mr. Donnithorne uncle, to you who are not aware, it seems, that I am only an adopted niece."

"Not aware of it! Of course not," said Oliver, throwing himself into a large arm-chair, while his fair companion busied herself in spreading the board for a substantial meal. "I could not be aware of much that has occurred in this distant part of the kingdom, seeing that my worthy uncle has vouchsafed to write me only two letters in the course of my life; once, many years ago, to condole with me—in about ten lines, address and signature included—on the death of my dear mother; and once again to tell me he had procured an appointment for me as assistant-surgeon in the mining district of St. Just. He must have been equally uncommunicative to my mother, for she never mentioned your existence. However, since I have now made the agreeable discovery, I trust that you will dispense with ceremony, and allow me at once to call you cousin. By the way, you have not yet told me your name."

The maiden, who was charmingly unsophisticated, replied that her name was Rose Ellis, and that she had no objection whatever to being called cousin without delay.

"Well, cousin Rose," said Oliver, "if it be not prying into secrets, I should like to know how long it is since my uncle adopted you."

"About nineteen years ago," replied Rose.

"Oh!" said Oliver remonstratively, "before you were born? impossible!"

Rose laughed—a short clear little laugh which she nipped in the bud abruptly, and replied—

"Well, it was only a short time after I was born. I was wrecked on this coast"—the expressive face here became very grave—"and all on board our ship perished except myself."

Oliver saw at once that he had touched on a tender subject, and hastened to change it by asking a number of questions about his uncle, from which he gradually diverged to the recent events in his own history which he began to relate with much animation. His companion was greatly interested and amused. She laughed often and heartily in a melodious undertone, and Oliver liked her laugh, for it was peculiar, and had the effect of displaying a double row of pretty little teeth, and of almost entirely shutting up her eyes. She seemed to enjoy a laugh so much that he exerted all his powers to tickle her risible faculties, and dwelt long and graphically on his meeting with the irascible old gentleman in the lane. He was still busy with this part of his discourse when a heavy step was heard outside.

"There's my uncle," exclaimed Rose, springing up.

A moment after the door opened, and in walked the identical irascible old gentleman himself!

If a petrified impersonation of astonishment had been a possibility, Oliver Trembath would, on that occasion, have presented the phenomenon. He sat, or rather lay, extended for at least half a minute with his eyes wide and his mouth partly open, bereft alike of the powers of speech and motion.

"Heyday, young man!" exclaimed the old gentleman, planting his sturdy frame in the middle of the floor as if he meant then and there to demand and exact an ample apology, or to inflict condign and terrible chastisement for past misdeeds; "you appear to be making yourself quite at home—eh?"

"My *dear* sir!" exclaimed Oliver, leaping up with a look of dismay; "how can I express my—my—but is it, *can* it be possible that you are Mr. Donnithorne—m—my—uncle?"

Oliver's expression, and the look of amazement on the countenance of Rose Ellis, who could not account for such a strange reception of her newly-found cousin, proved almost too much for the old gentleman, whose eyes had already begun to twinkle.

"Ay, young man, I am Tom Donnithorne, your uncle, the vile old smuggling brandy-loving rascal, who met his respectful nephew on the road to St. Just,"—at this point Rose suddenly pressed her hand over her mouth, darted to her own apartment in a distant corner of the house, and there, seated on her little bed, went into what is not inaptly styled fits of laughter,—"and who now," continued the old gentleman, relaxing into a genial smile, and grasping his nephew's hand, "welcomes Oliver Trembath to his house, with all his heart and soul; there, who will say after that, that old Donnithorne does not know how to return good for evil?"

"But, my dear uncle," began Oliver, "allow me to explain—"

"Now, now, look at that—kept me hours too late for supper already, and he's going to take up more time with explanations," cried the old gentleman, flinging himself on the chair from which Oliver had risen, and wiping his bald pate with a red silk handkerchief. "What *can* you explain, boy, except that you met an angry old fellow in a lane who called your uncle such hard names that you couldn't help giving him a bit of your mind—there, there, sit down, sit down.—Hallo!" he shouted, starting up impulsively and thrusting his head into the passage, "Rose, Rose, I say, where are you?—hallo!"

"Coming, uncle—I'm here."

The words came back like an echo, and in another minute Rose appeared with a much-flushed countenance.

"Come along, lass, let's have supper without delay. Where is aunty? Rout her out, and tell that jade of a cook that if she don't dish up in five minutes I'll—I'll—. Well, Oliver, talking of explanations, how comes it that you are so late?"

"Because I took the wrong road after leaving you in the lane," replied the youth, with a significant glance at his uncle, whose eyes were at the moment fixed gravely on the ground.

"The wrong road—eh?" said Mr. Donnithorne, looking up with a sly glance, and then laughing. "Well, well, it was only *quid pro quo*, boy; you put a good deal of unnecessary earth and stones over my head, so I thought it was but fair that I should put a good deal more of the same under your feet, besides giving you the advantage of seeing the Land's End, which, of course, every youth of intelligence must take a deep interest in beholding. But, sure, a walk thither, and thence to St. Just, could not have detained you so long?"

"Truly no," replied Oliver; "I had a rencontre—a sort of adventure with fishermen, which—"

"Fishermen!" exclaimed Mr. Donnithorne in surprise; "are ye sure they were not smugglers—eh?"

"They said they were fishermen, and they looked like such," replied Oliver; "but my adventure with them, whatever they were, was the cause of my detention, and I can only express my grief that the circumstance has incommoded your household, but, you see, it took some time to beat off the boat's crew, and then I had to examine a wound and extract—"

"What say you, boy!" exclaimed Mr. Donnithorne, frowning, "beat off a boat's crew—examine a wound! Why, Rose, Molly, come hither. Here we have a young gallant who hath begun life in the far west in good style;—but hold, here comes my excellent friend Captain Dan, who is no friend to the smugglers; he is to sup with us to-night; so we will repress our curiosity till after supper. Let me introduce you, Oliver, to my wife, your aunt Molly, or, if you choose to be respectful, Aunt Mary."

As he spoke, a fat, fair, motherly-looking lady of about five-and-forty entered the room, greeting her husband with a rebuke, and her nephew with a smile.

"Never mind him, Oliver," said the good lady; "he is a vile old creature. I have heard all about your meeting with him this forenoon, and only wish I had been there to see it."

"Listen to that now, Captain Dan," cried Mr. Donnithorne, as the individual addressed entered the room; "my wife calls me—me, a staid sober man of fifty-five—calls me a vile old creature. Is it not too bad? really one gets no credit now-a-days for devoting one's-self entirely to one's better half; but I forget: allow me to introduce you to my nephew, Oliver Trembath, just come from one of the Northern Universities to fight the smugglers of St. Just,—of which more anon. Oliver, Captain Hoskin of Botallack, better known as Captain Dan. Now, sit down and let's have a bit of supper."

With hospitable urgency Mr. Donnithorne and his good dame pressed their guests to do justice to the fare set before them, and, during the course of the meal, the former kept up a running fire of question, comment, and reply on every conceivable subject, so that his auditors required to do little more than eat and listen. After supper, however, and when tumblers and glasses were being put down, he gave the others an opportunity of leading the conversation.

"Now, Oliver," he said, "fill your glass and let us hear your adventures. What will you have—brandy, gin, or rum? My friend, Captain Dan here, is one of those remarkable men who don't drink anything stronger than ginger-beer. Of course you won't join *him*."

"Thank you," said Oliver. "If you will allow me, I will join your good lady in a glass of wine. Permit me, Aunt Mary, to fill—"

"No, I thank you, Oliver," said Mrs. Donnithorne good-humouredly but firmly, "I side with Captain Dan; but I'll be glad to see you fill your own."

"Ha!" exclaimed Mr. Donnithorne, "Molly's sure to side with the opponent of her lawful lord, no matter who or what he be. Fill your own glass, boy, with what you like—cold water, an' it please you—and let us drink the good old Cornish toast, 'Fish, tin, and copper,' our three staples, Oliver—the bone, muscle, and fat of the county."

"Fish, tin, and copper," echoed Captain Dan.

"In good sooth," continued Mr. Donnithorne, "I have often thought of turning teetotaller myself, but feared to do so lest my wife should take to drinking, just out of opposition. However, let that pass—and now, Oliver, open thy mouth, lad, and relate these surprising adventures of which you have given me a hint."

"Indeed, uncle, I do not say they are very surprising, although, doubtless, somewhat new to one who has been bred, if not born, in comparatively quiet regions of the earth."

Here Oliver related circumstantially to his wondering auditors the events which befell him after the time when he left his uncle in the lane—being interrupted only with an occasional exclamation—until he reached the part when he knocked down the man who had rescued him from the waves, when Mr. Donnithorne interrupted him with an incontrollable burst.

"Ha!" shouted the old gentleman; "what! knocked down the man who saved your life, nephew? Fie, fie! But you have not told us his name yet. What was it?"

"His comrades called him Jim, as I have said; and I think that he once referred to himself as Jim Cuttance, or something like that."

"What say you, boy?" exclaimed Mr. Donnithorne, pushing back his chair and gazing at his nephew in amazement. "Hast fought side by side with Jim Cuttance, and then knocked him down?"

"Indeed I have," said Oliver, not quite sure whether his uncle regarded him as a hero or a fool.

The roar of laughter which his answer drew from Captain Dan and his uncle did not tend to enlighten him much.

"Oh! Oliver, Oliver," said the old gentleman, on recovering some degree of composure, "you should have lived in the days of good King Arthur, and been one of the Knights of the Round Table. Knocked down Jim Cuttance! What think 'ee, Captain Dan?"

"I think," said the Captain, still chuckling quietly, "that the less our friend says about the matter the better for himself."

"Why so?" inquired Oliver quickly.

"Because," replied his uncle, with some return of gravity, "you have assisted one of the most notorious smugglers that ever lived, to fight his Majesty's coast-guard—that's all. What say you, Molly—shall we convict Oliver on his own confession?"

The good lady thus appealed to admitted that it was a serious matter, but urged that as Oliver did the thing in ignorance and out of gratitude, he ought to be forgiven.

"*I* think he ought to be forgiven for having knocked down Jim Cuttance," said Captain Dan.

"Is he then so notorious?" asked Oliver.

"Why, he is the most daring smuggler on the coast," replied Captain Dan, "and has given the preventive men more trouble than all the others put together. In fact, he is a man who deserves to be hanged, and will probably come to his proper end ere long if not shot in a brawl beforehand."

"I fear he stands some chance of it now," said

Mr. Donnithorne, with a sigh, "for he has been talking of erecting a battery near his den at Prussia Cove, and openly defying the Government men."

' You seem to differ from Captain Dan, uncle, in reference to this man," said Oliver, with a smile.

"Truly, I do, for although I condemn smuggling, —ahem!" (the old gentleman cast a peculiar glance at the Captain,) "I don't like to see a sturdy man hanged or shot—and Jim Cuttance is a stout fellow. I question much whether you could find his match, Captain Dan, amongst all your men?"

"That I could, easily," said the Captain, with a quiet smile.

"Pardon me, Captain," said Oliver, "my uncle has not yet informed me on the point. May I ask what corps you belong to?"

"To a sturdy corps of tough lads," answered the Captain, with another of his quiet smiles,—"men who have smelt powder, most of 'em, since they were little boys—live on the battle-field, I may say, almost night and day—spring more mines in a year than all the soldiers in the world put together—and shorten their lives by the stern labour they undergo; but they burn powder to raise, not to waste, metal. Their uniform is red, too, though not quite so red, nor yet so elegant, as that of the men in his Majesty's service. I am one of the underground Captains, sir, of Botallack mine."

Captain Dan's colour heightened a very little and the tones of his voice became a little more powerful as he concluded this reply; but there was no other indication that the enthusiastic soul of one of the "captains" of the most celebrated mine in Cornwall was moved. Oliver felt, however, the contact with a kindred spirit, and, expressing much interest in the mines, proceeded to ask many questions of the Captain, who, nothing loath, answered all his queries, and explained to him that he was one of the "captains," or "agents," whose duty it was to superintend the men and the works below the surface—hence the title of "underground;" while those who superintended the works aboveground were styled "grass, or surface captains." He also made an appointment to conduct the young doctor underground, and go over the mine with him at an early date.

While the party in old Mr. Donnithorne's dwelling were thus enjoying themselves, a great storm was gathering, and two events, very different from each other in character, were taking place—the one quiet, and apparently unimportant, the other tremendous and fatal—both bearing on and seriously influencing the subjects of our tale.

CHAPTER IV.

AT WORK UNDER THE SEA.

Chip, chip, chip,—down in the dusky mine! Oh, but the rock at which the miner chipped was hard, and the bit of rock on which he sat was hard, and the muscles with which he toiled were hard from prolonged labour; and the lot of the man seemed hard, as he sat there in the hot, heavy atmosphere, hour after hour, from morn till eve, with the sweat pouring down his brow and over his naked shoulders, toiling and moiling with hammer and chisel.

But stout David Trevarrow did not think his lot peculiarly hard. His workshop was a low narrow tunnel deep down under the surface of the earth—ay, and deep under the bottom of the sea! His daily sun was a tallow-candle, which rose regularly at seven in the morning and set at three in the afternoon. His atmosphere was sadly deficient in life-giving oxygen, and much vitiated by gunpowder-smoke. His working costume consisted only of a pair of linen trousers; his colour from top to toe was red as brick-dust, owing to the iron-ore around him; his food was a slice of bread, with, perchance, when he was unusually luxurious, the addition of a Cornish pasty; and his drink was water. To an inexperienced eye the man's work would have appeared not only hard but hopeless, for although his hammer was heavy, his arm strong, and his chisel sharp and tempered well, each blow produced an apparently insignificant effect on the flinty rock. Frequently a spark of fire was all that resulted from a blow, and seldom did more than a series of little chips fly off, although the man was of herculean mould, and worked "with a will," as was evident from the kind of gasp or stern expulsion of the breath with which each blow was accompanied. Unaided human strength he knew could not achieve much in such a process, so he directed his energies chiefly to the boring of blast-holes, and left it to the mighty power of gunpowder to do the hard work of rending the rich ore from the bowels of the unwilling earth. Yes, the work was very hard, probably the hardest that human muscles are ever called on to perform in this toiling world, but again we say that David Trevarrow did not think so, for he had been born to the work and bred to it, and was blissfully ignorant of work of a lighter kind; so that, although his brows frowned at the obstinate rock, his compressed lips smiled, for his thoughts were pleasant and far away. The unfettered mind was aboveground, roaming in fields of light, basking in sunshine, and holding converse with the birds, as he sat there chip, chip, chipping, down in the dusky mine.

Stopping at last, the miner wiped his brow, and, rising, stood for a few moments silently regarding the result of his day's work.

"Now, David," said he to himself, "the question is, what shall us do—shall us keep on, or shall us knack?"

He paused, as if unable to answer the question. After a time he muttered, "Keep on; it don't look promisin', sure 'nuff, an' it 's poor pay; but it won't do to give in yet."

Poor pay it was indeed, for the man's earnings during the past month had been barely ten shillings. But David Trevarrow had neither wife, child, nor mother to support, so he could afford to toil for poor pay, and, being of a remarkably hopeful and cheery disposition, he returned home that afternoon resolved to persevere in his unproductive toil, in the hope that at last he should discover a good "bunch of copper," or a "keenly lode of tin."

David was what his friends and the world styled unfortunate. In early manhood he had been a somewhat wild and reckless fellow—a noted wrestler, and an adept in all manly sports and games. But a disappointment in love had taught him very bitterly that life is not all sunshine, and this, coupled with a physical injury which was the result of his own folly, crushed his spirit so much that his comrades believed him to be a "lost man."

The injury referred to was the bursting of a blood-vessel in the lungs. It was, and still is, the custom of the youthful miners of Cornwall to test their strength by racing up the almost interminable ladders by which the mines are reached. This tremendous exertion after a day of severe toil affected them of course very severely, and in some cases seriously. Many an able-bodied man has by this means brought himself to a premature end. Among others, David Trevarrow excelled and suffered. No one could beat him in running up the ladders; but one day, on reaching the surface, blood issued from his mouth, and thenceforth his racing and wrestling days were ended, and his spirit was broken. A long illness succeeded. Then he began to mend. Slowly and by degrees his strength returned, but not his joyous spirit. Still it was some comfort to feel able for work again, and he "went underground" with some degree of his old vigour, though not with the light heart or light step of former days; but bad fortune seemed to follow him everywhere. When others among his comrades were fortunate in finding copper or tin, David was most unaccountably unsuccessful. Accidents, too, from falls and explosions, laid him up more than once, and he not only acquired the character of an unlucky man from his friends, but, despite a naturally sanguine temperament, he began himself to believe that he was one of the unluckiest fellows in the world.

About this time the followers of that noble Christian, John Wesley, began to make an impression on Cornwall, and to exert an influence which created a mighty change in the hearts and manners of the people, and the blessed effects of which are abundantly evident at the present day—to the rejoicing of every Christian soul. One of those ministers of our Lord happened to meet with David Trevarrow, and was the means of opening his eyes to many great and previously unknown truths. Among others, he convinced him that "God's ways are not as man's ways;" that He often, though not always, leads His people by thorny paths that they know not of, but does it in love and with His own glory in their happiness as the end in view; that the Lord Jesus Christ must be to a man "the chiefest among ten thousand, and altogether lovely," else He is to him nothing at all, and that he could be convinced of all these truths only by the Holy Spirit.

It were vain to attempt to tell all that this good man said to the unhappy miner, but certain it is that from that time forth David became himself again—and yet, not himself. The desire to wrestle and fight and race returned in a new form. He began to wrestle with principalities and powers, to fight the good fight of faith, and to run the race set before him in the gospel. The old hearty smile and laugh and cheery disposition also returned, and the hopeful spirit, and so much of the old robust health and strength, that it seemed as if none of the evil effects of the ruptured blood-vessel remained. So David Trevarrow went, as of old, daily to the mine. It is true that riches did not flow in upon him any faster than before, but he did not mind that much, for he had discovered another mine, in which he toiled at nights after the day's toil was over, and whence he extracted treasure of greater value than copper or tin, or even gold—treasure which he scattered in a Sabbath-school with liberal hand and found himself all the richer for his prodigality.

Occasionally, after prolonged labour in confined and bad air, a faint trace of the old complaint showed itself when he reached the top of the ladders, but he was not now depressed by that circumstance as he used to be. He was past his prime at the period of which we write, and a confirmed bachelor.

To return from this digression: David Trevarrow made up his mind, as we have said, to "go on," and, being a man of resolute purpose, he went on; seized his hammer and chisel, and continued perseveringly to smite the flinty rock, surrounded by thick darkness, which was not dispelled but only rendered visible by the feeble light of the tallow-candle that flared at his side.

Over his head rolled the billows of the Atlantic; the whistling wind howled among the wild cliffs of the Cornish coast, but they did not break the deep silence of the miner's place of midnight toil. Heaven's artillery was rending the sky, and causing the hearts of men to beat slow with awe. The great boulders ground the pebbles into sand as they crashed to and fro above him, but he heard them not— or if he did, the sound reached him as a deep-toned mysterious murmur, for, being in one of the low levels, with many fathoms of solid rock between him and the bottom of the superincumbent sea, he was beyond the reach of such disturbing influences, tremendous though they were.

The miner was making a final effort at his unproductive piece of rock, and had prolonged his toil far into the night.

Hour after hour he wrought almost without a moment's respite, save for the purpose, now and then, of trimming his candle. When his right arm grew tired, he passed the hammer swiftly to his left hand, and, turning the borer with his right, continued to work with renewed vigour.

At last he paused, and looking over his shoulder called out—"Zackey, booy."

The sound died away in a hollow echo through the retiring galleries of the mine, but there was no reply.

"Zackey, booy, are 'ee slaipin?" he repeated.

A small reddish-coloured bundle, which lay in a recess close at hand, uncoiled itself like a hedgehog, and, yawning vociferously, sat up, revealing the fact that the bundle was a boy.

"Ded 'ee call, uncle?" asked the boy in a sleepy tone.

"Iss did I," said the man; "fetch me the powder an' fuse, my son."

The lad rose, and, fetching out of a dark corner the articles required, assisted in charging the hole which his uncle had just finished boring. This was the last hole which the man intended to blast that night. For weeks past he had laboured day after day—sometimes, as on the present occasion, at night—and had removed many tons of rock, without procuring either tin or copper sufficient to repay him for his toil, so that he resolved to give it up and remove to a more hopeful part of the mine, or betake himself to another mine altogether. He had now bored his last hole, and was about to blast it. Applying his candle to the end of the fuse, he hastened along the level to a sufficient distance to afford security, warning his nephew as he passed.

Zackey leaped up, and, scrambling over the *débris* with which the bottom of the level was covered, made good his retreat. About a minute they waited in expectancy. Suddenly there was a bright blinding flash, which lit up the rugged sides of the mine, and revealed its cavernous ramifications and black depths. This was accompanied by a dull smothered report and a crash of falling rock, together with a shower of *débris*. Instantly the whole place was in profound darkness.

"Aw, booy," exclaimed the miner; "we was too near. It have knacked us in the dark."

"So 't have, uncle; I'll go an' sarch for the box."

"Do, my son," said David.

In those days lucifer-matches had not been invented, and light had to be struck by means of flint, steel, and tinder. The process was tedious compared with the rapid action of congreves and vestas in the present day. The man chipped away for full three minutes before he succeeded in relighting his candle. This done, the rock was examined.

"Bad still, Uncle David?" inquired the boy.

"Iss, Zackey Maggot, so we'll knack'n, and try the higher mine to-morrow." Having come to this conclusion Uncle David threw down the mass of rock which he held in his brawny hands, and, picking up his implements, said—"Get the tools, booy, and lev us go to grass."

Zackey, who had been in the mine all day, and was tired, tied his tools at each end of a rope, so that they might be slung over his shoulder and leave his hands free. Trevarrow treated his in the same way, and, removing his candle from the wall, fixed it on the front of his hat by the simple process of sticking thereto the lump of clay to which it was attached. Zackey having fixed his candle in the same manner, both of them put on their red-stained flannel shirts and linen coats, and traversed the level until they reached the bottom of the ladder shaft. Here they paused a few moments before commencing the long wearisome ascent of almost perpendicular ladders by which the miners descended to their work or returned "to grass," as they termed the act of returning to the surface.

It cost them more than half-an-hour of steady climbing before they reached the upper part of the shaft and became aware that a storm was raging in the regions above. On emerging from the mouth of the shaft or "ladder road," man and boy were in a profuse perspiration, and the sharp gale warned them to hasten to the moor-house at full speed.

Moor-houses were little buildings in which miners were wont to change their wet underground garments for dry clothes. Some of these used to be at a considerable distance from the shafts, and the men were often injured while going to them from the mines, by being exposed in an overheated state to cutting winds. Many a stout able-bodied miner has had a chill given him in this way which has resulted in premature death. Moor-houses have now been replaced by large drying-houses, near the mouths of shafts, where every convenience is provided for the men drying their wet garments and washing their persons on coming to the surface.

Having changed their clothes, uncle and nephew hastened to St. Just, where they dwelt in the cottage of Maggot the blacksmith. This man, who has already been introduced to the reader, was brother-in-law to David, and father to Zackey.

When David Trevarrow entered his brother-in-law's cottage, and told him of his bad fortune, and of his resolution to try his luck next day in the higher mine, little did he imagine that his change of purpose was to be the first step in a succession of causes which were destined to result, at no very distant period, in great changes of fortune to some of his friends in St. Just, as well as to many others in the county.

CHAPTER V.

DESCRIBES A WRECK AND SOME OF ITS CONSEQUENCES.

WHILE the miner had been pursuing his toilsome work in the solitude and silence of the level under the sea, as already described, a noble ship was leaping over the Atlantic waves—homeward bound—to Old England.

She was an East-Indiaman, under close-reefed sails, and, although she bent low before the gale so that the waves almost curled over her lee bulwarks, she rose buoyantly like a sea-gull, for she was a good ship, stout of plank and sound of timber, with sails and cordage to match.

Naturally, in such a storm, those on board were anxious, for they knew that they were drawing near to land, and that "dear Old England" had an ugly seaboard in these parts—a coast not to be too closely hugged in what the captain styled "dirty weather, with a whole-gale from the west'ard," so a good look-out was kept. Sharp eyes were in the foretop looking out for the guiding rays of the Longships lighthouse, which illumine that part of our rocky shores to warn the mariner of danger, and direct him to a safe harbour. The captain stood on the "foge's'l" with stern gaze and compressed lip. The chart had been consulted, the bearings correctly noted, calculations made, and leeway allowed for. Everything in fact that could be done by a commander who knew his duty had been done for the safety of the ship—so would the captain have said probably, had he lived to be questioned as to the management of his vessel. But everything had *not* been done. The lead, strange to say, had not been hove. It was ready to heave, but the order was delayed. Unaccountable fatality! The only safe guide that remained to the good ship on that wild night was held in abeyance. It was deemed unnecessary to heave it yet, or it was troublesome, and they would wait till nearer the land. No one now can tell the reasons that influenced the captain, but *the lead was not used.* Owing to similar delay or neglect, hundreds upon hundreds of ships have been lost, and thousands of human lives have been sacrificed!

The ship passed like a dark phantom over the very head of the miner who was at work many fathoms below the bottom of the sea.

"Land, ho!" came suddenly in a fierce, quick shout from the mast-head.

"Starboard! starboard—hard!" cried the captain, as the roar of breakers ahead rose above the yelling of the storm.

Before the order was obeyed or another word spoken the ship struck, and a shriek of human terror followed, as the fore-mast went by the board with a fearful crash. The waves burst over the stern, sweeping the decks fore and aft. Wave after wave lifted the great ship as though it had been a child's toy, and dashed her down upon the rocks. Her bottom was stove in, her planks and timbers were riven like matchwood. Far down below man was destroying the flinty rock, while overhead the rock was destroying the handiwork of man! But the destruction in the one case was slow, in the other swift. A desperate but futile effort was made by the crew to get out the boats, and the passengers, many of whom were women and children, rushed frantically from the cabin to the deck, and clung to anything they could lay hold of, until strength failed, and the waves tore them away.

One man there was in the midst of all the terror-stricken crew who retained his self-possession in that dread hour. He was a tall stern old man with silver locks—an Indian merchant, one who had spent his youth and manhood in the wealthy land collecting gold—"making a fortune," he was wont to say,—and who was returning to his fatherland to spend it. He was a thinking and calculating man, and in the anticipation of some such catastrophe as had actually overtaken him, he had secured some of his most costly jewels in a linen belt. This belt, while others were rushing to the boats, the old man secured round his waist, and then sprang on deck, to be swept, with a dozen of his fellow-passengers, into the sea by the next wave that struck the doomed vessel. There was no one on that rugged coast to lend a helping hand. Lifeboats did not then, as now, nestle in little nooks on every part of our dangerous coasts. No eye was there to see nor ear to hear, when, twenty minutes after she struck, the East-Indiaman went to pieces, and those of her crew and passengers who had retained their hold of her uttered their last despairing cry, and their souls returned to God who gave them.

It is a solemn thought that man may with such awful suddenness, and so unexpectedly, be summoned into the presence of his Maker. Thrice happy they who, when their hearts grow chill and their grasps relax as the last plank is rending, can say—"Neither death, nor life, nor any other creature, is able to separate us from the love of God, which is in Christ Jesus our Lord."

The scene we have described was soon over, and the rich cargo of the East-Indiaman was cast upon the sea and strewn upon the shore, affording much work for many days to the coast-guard, and greatly exciting the people of the district—most of whom appeared to entertain an earnest belief in the doctrine that everything cast by storms upon their coast ought to be considered public property. Portions of the wreck had the name "Trident" painted on them, and letters found in several chests which were washed ashore proved that the ship had sailed from Calcutta, and was bound for the port of London. One little boy alone escaped the waves. He was found in a crevice of the cliffs the following day, with just enough vitality left to give a few details of the wreck. Although all possible care was bestowed on him, he died before night.

Thus sudden and complete was the end of as fine a ship as ever spread her canvas to the breeze. At night she had been full of life—full of wealth; in the morning she was gone—only a few bales and casks and broken spars to represent the wealth, and stiffened corpses to tell of the life departed. So she came and went, and in a short time all remnants of her were carried away.

One morning, a few weeks after the night of the storm, Maggot the smith turned himself in his bed at an early hour, and, feeling disinclined to slumber, got up to look at the state of the weather. The sun was just rising, and there was an inviting look about the morning which induced the man to dress hastily and go out.

Maggot was a powerfully-built man, rough in his outer aspect as well as in his inner man, but by no means what is usually termed a bad man, although, morally speaking, he could not claim to be considered a good one. In fact, he was a hearty, jolly, reckless fisherman, with warm feelings, enthusiastic temperament, and no principle; a man who, though very ready to do a kind act, had no particular objection to do one that was decidedly objectionable, when it suited his purpose or served his present interest. He was regarded by his comrades as one of the greatest madcaps in the district. Old Maggot was, as we have said, a blacksmith to trade, but he had also been bred a miner, and was something of a fisherman as well, besides being (like most of his companions) an inveterate smuggler. He could turn his hand to almost anything, and was "everything by turns, but nothing long."

Sauntering down to Priests Cove on the south of Cape Cornwall, with his hands in his pockets and his sou'-wester stuck carelessly on his shaggy head, he fell in with a comrade whom he hailed by the name of John Cock. This man was also a fisherman, *et cetera,* and the bosom friend and admirer of Maggot.

"Where bound to this mornin', Jack?" inquired Maggot.

"To fish," replied John.

"I go with 'ee, booy," said Maggot.

This was the extent of the conversation at that time. They were not communicative, but walked side by side in silence to the beach, where they launched their little boat and rowed out to sea.

Presently John Cock looked over his shoulder and exclaimed—"Maggot, I see summat."

"Do 'ee?"

"Iss do I."

"What do un look like?"

"Like a dead corp."

"Aw, my dear," said Maggot, "lev us keep away. It can do no good to we."

Acting on this opinion the men rowed past the object that was floating on the sea, and soon after began to fish; but they had not fished long when the dead body, drifted probably by some cross-current, appeared close to them again. Seeing this they changed their position, but ere long the body again appeared

"P'raps," observed Maggot, "there's somethin' in its pockets."

As the same idea had occurred to John Cock, the men resolved to examine the body, so they rowed up to it and found it to be that of an elderly man, much decomposed, and nearly naked. A very short examination sufficed to show that the pockets of such garments as were still upon it were empty, and the men were about to let it go again, when Maggot exclaimed—

"Hold fast, Jack, I see somethin' tied round the waist of he; a sort o' belt it do seem."

The belt was quickly removed and the body released, when it sank with a heavy plunge, but ere long reappeared on the surface. The fishermen rowed a considerable distance away from it, and then shipped their oars and examined the belt, which was made of linen. Maggot sliced it up as he would have ripped up a fish, and laid bare to the astonished gaze of himself and his friend a number of glittering gems of various colours, neatly and firmly embedded in cotton, besides a variety of rings and small brooches set with precious stones.

"Now, I tell 'ee," said Maggot, "'tis like as this here will make our fortin', or else git we into trouble."

"Why, whatever shud we git into trouble 'bout it for?" said John Cock. "'Tis like as not they ain't real—only painted glass, scarce wuth the trouble o' car'in ashore."

"Hould thy tongue, thee g'eat chucklehead," replied Maggot; "a man wouldn't go for to tie such stuff round his waist to drown hisself with, I do know, if they worn't real. Lev us car' 'em to Maister Donnithorne."

John Cock replied with a nod, and the two men, packing up the jewels, pulled in shore as fast as possible. Hauling their boat beyond the reach of the surf, they hastened to St. Just, and requested a private audience of Mr. Donnithorne.*

That excellent gentleman was not unaccustomed to give private audiences to fishermen, and, as has been already hinted at the beginning of this tale, was reported to have private dealings with them also—of a very questionable nature. He received the two men, however, with the hearty air of a man who knows that the suspicions entertained of him by the calumnious world are false.

"Well, Maggot," said Mr. Donnithorne, "what is your business with me? You are not wont to be astir so early, if all be true that is reported of 'ee."

"Plaise, sur," said Maggot with a glance at Rose Ellis, who sat sewing near the window, "I'm come to talk 'bout private matters—if—"

"Leave us, Rose dear, for a little," said the old gentleman.

As soon as she was out of the room Maggot locked the door, a proceeding which surprised Mr. Donnithorne not a little, but his surprise was much greater when the man drew a small parcel from the breast of his rough coat, and, unrolling it, displayed the glittering jewels of which he had so unexpectedly become possessed.

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* It may be well here to inform the reader that the finding of the jewels as here described and the consequences which followed are founded on fact.

"Where got you these?" inquired Mr. Donnithorne, turning them over carefully.

"Got 'em in the say—catched 'em, sure 'nough," said Maggot.

"Not with a baited hook, I warrant," said the old gentleman. "Come, my son, let 's hear all about it."

Maggot explained how he had obtained the jewels, and then asked what they were worth.

"I can't tell that," said Mr. Donnithorne, shaking his head gravely. "Some of them are undoubtedly of value; the others, for all I know, may not be worth much."

"Come now, sur," said Maggot, with a confidential leer, "it 's not the fust time we have done a bit o' business. I 'spose I cud claim salvage on 'em?"

"I don't know that," said the old gentleman; "you cannot tell who they belonged to, and I suspect Government would claim them if—. But, by the way, I suppose you found no letters—nothing in the shape of writing on the body?"

"Nothin' whatsomever."

"Well, then, I fear that—"

"Come now, sur," said Maggot boldly, "s'pose you gives John and me ten pounds a paice an' kape em to yourself to make what 'ee can of 'em?"

Mr. Donnithorne shook his head and hesitated. Often before had he defrauded the revenue by knowingly purchasing smuggled brandy and tobacco, and by providing the funds to enable others to smuggle it, but then the morality of that day in regard to smuggling was very lax, and there were men who, although in all other matters truly honest and upright, could not be convinced of the sinfulness of smuggling, and smiled when they were charged with the practice, but who, nevertheless, would have scorned to steal or tell a downright lie. This, however, was a very different matter from smuggling. The old gentleman shrank from it at first, and could not meet the gaze of the smuggler with his usual bold frank look. But the temptation was great. The jewels he suspected were of immense value, and his heart readily replied to the objections raised by his conscience, that after all there was no one left to claim them, and he had a much better right to them, in equity if not in law, than Government; and as to the fellows who found them—why, the sum they asked would be a great and rich windfall to them, besides freeing them from all further trouble, as well as transferring any risk that might accrue from their shoulders to his own.

While the old gentleman was reasoning thus with himself, Maggot stood anxiously watching his countenance and twisting the cloth that had enclosed the jewellery into a tight rope, as he shifted his position uneasily. At length old Mr. Donnithorne said—

"Leave the jewels with me, and call again in an hour from this time. You shall then have my answer."

Maggot and his friend consented to this delay, and left the room.

No sooner were they gone than the old gentleman called his wife, who naturally exclaimed in great surprise on beholding the table covered with such costly trinkets—

"Where *ever* did you get these, Tom?"

Mr. Donnithorne explained, and then asked what she thought of Maggot's proposal.

"Refuse it," said she firmly.

"But, my dear—."

"Don't 'but' about it, Tom. Whenever a man begins to 'but' with sin, it is sure to butt him over on his back. Have nothing to do with it, *I* say."

"But, my dear, it is not dishonest—"

"I don't know that," interrupted Mrs. Donnithorne vigorously; "you think that smuggling is not dishonest, but I do, and so does the minister."

"What care *I* for the minister?" cried the old gentleman, losing his temper; "who made *him* a judge of my doings?"

"He is an expounder of God's Word," said Mrs. D. firmly, "and holds that 'Thou shalt not steal' is one of the Ten Commandments."

"Well, well, he and I don't agree, that's all; besides, has he never expounded to you that obedience to your husband is a virtue—a commandment, I may say, which you are—"

"Mr. Donnithorne," said the lady with dignity, "I am here at your request, and am now complying with your wishes in giving my opinion."

"There, there, Molly," said the subdued husband, giving his better-half a kiss, "don't be so sharp. You ought to have been a lawyer with your powerful reasoning capacity. However, let me tell you that you don't understand these matters—"

"Then why ask my advice, Tom?"

"Why, woman, because an inexplicable fatality leads me to consult you, although I know well enough what the upshot will be. But I'm resolved to close with Maggot."

"I knew you would," said Mrs. Donnithorne quietly.

This last remark was the turning-point. Had the good lady condescended to be *earnest* in her entreaties that the bargain should not be concluded, it is highly probable her husband would have given in, but her last observation nettled him so much that he immediately hoisted a flag of defiance, nailed it to the mast, and went out in great indignation to search for Maggot. That individual was not far off. The bargain was completed, the jewels were locked up in one of the old gentleman's secret repositories, and the fishermen, with ten pounds apiece in their pockets, returned home.

CHAPTER VI.

TREATS OF THE MINER'S COTTAGE, WORK, AND COSTUME.

MAGGOT'S home was a disordered one when he reached it, for his youngest baby, a fat little boy, had been seized with convulsions, and his wife and little daughter Grace, and son Zackey, and brother-in-law David Trevarrow, besides his next neighbour Mrs. Penrose, with her sixteen children, were all in the room, doing their best by means of useless or hurtful applications, equally useless advice, and intolerable noise and confusion, to cure, if not to kill, the baby.

Maggot's cottage was a poor one, his furniture was mean, and there was not much of it, nevertheless its inmates were proud of it, for they lived in comparative comfort there. Mrs. Maggot was a kind-hearted active woman, and her husband—despite his smuggling propensities, was an affectionate father. Usually, the cottage was kept in a most orderly condition; but on the present occasion it was, as we have said, in a state of great confusion.

"Fetch me a bit of rag, Grace," cried Mrs. Maggot just as her husband entered.

"Here's a bit, old 'ooman," said Maggot, handing her the linen cloth in which the jewels had been wrapped up, and which he had unconsciously retained in his hands on quitting Mr. Donnithorne.—"Run, my dear man," he added, turning to John Cock, "an' fetch the noo doctor."

John darted away, and in a quarter of an hour returned with Oliver Trembath, who found that the baby had weathered the storm by the force of its own constitution, despite the adverse influences that were around it. He therefore contented himself with clearing the place of intruders, and prescribing some simple medicine.

"Are you going to work?" inquired Oliver of David Trevarrow, observing that the man was about to quit the cottage.

"Iss, sur—to Botallack."

"Then I will accompany you. Captain Dan is going to show me over part of the mine to-day. Good-morning, Mrs. Maggot, and remember my directions if this should happen to the little fellow again."

Leaving the cottage the two proceeded through the town to the north end of it, accompanied by Maggot, who said he was going to the forge to do a bit of work, and who parted from them at the outskirts of the town.

"Times are bad with you at the mines just now, I find," said Oliver as they walked along.

"Iss sur, they are," replied Trevarrow, in the quiet tone that was peculiar to him; "but, thank God, we do manage to live, though there are some of us with a lot o' child'n as finds it hard work. The Bal* ain't so good as she once was."

'I suppose that you have frequent changes of fortune?" said Oliver.

The miner admitted that this was the case, for that sometimes a man worked underground for several weeks without getting enough to keep his family, while at other times he might come on a bunch of copper or tin which would enable him to clear £50 or more in a month.

"If report says truly," observed Oliver, "you have hit upon a 'keenly lode,' as you call it, not many days ago."

"A do look very well now, sur," replied the miner, "but wan can never tell. I did work for weeks in the level under the say without success, so I guv it up an' went to Wheal Hazard, and on the back o' the fifty-fethom level I did strike 'pon a small lode of tin 'bout so thick as my finger. It may get better, or it may take the bit in its teeth and disappear; we cannot tell."

"Well, I wish you good luck," said Oliver; "and here comes Captain Dan, so I'll bid you good morning."

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* The mine.

"Good morning, sur," said the stout-limbed and stout-hearted man, with a smile and a nod, as he turned off towards the moor-house to put on his mining garments.

Towards this house a number of men had been converging while Oliver and his companion approached it, and the former observed, that whatever colour the men might be on entering it, they invariably came out light red, like lobsters emerging from a boiling pot.

In Botallack mine a large quantity of iron is mingled with the tin ore. This colours everything in and around the mine, including men's clothes, hands, and faces, with a light rusty red. The streams, of course, are also coloured with it, and the various pits and ponds for collecting the fluid mud of tin ore seem as if filled with that nauseous compound known by the name of "Gregory's Mixture."

In the moor-house there were rows of pegs with red garments hung thereon to dry, and there were numerous broad-shouldered men dressing and undressing—in every stage of the process; while in a corner two or three were washing their bodies in a tank of water. These last were men who had been at work all night, and were cleansing themselves before putting on what we may term their home-going clothes.

The mining dress is a very simple, and often a very ragged affair. It consists of a flannel shirt, a pair of linen trousers, a short coat of the same, and a hat in the form of a stiff wide-awake, but made so thick as to serve the purpose of a helmet to guard the head from the rocks, etc. Clumsy ankle-boots complete the costume. As each man issued from the house, he went to a group of wooden chests which lay scattered about outside, and, opening his own, took from it a bag of powder, some blasting fuse, several iron tools, which he tied to a rope so as to be slung over his shoulder, a small wooden canteen of water, and a bunch of tallow-candles. These last he fastened to a button on his breast, having previously affixed one of them to the front of his hat.

Thus accoutred, they proceeded to a small platform close at hand, with a square hole in it, out of which protruded the head of a ladder. This was the "ladder road." Through the hole these red men descended, one by one, chatting and laughing as they went, and disappeared, leaving the moor-house and all around it a place of solitude.

Captain Dan now prepared to descend this ladder-road with Oliver Trembath.

CHAPTER VII.

TELLS OF THE GREAT MINE AND OF A ROYAL DIVE UNDER THE SEA.

BOTALLACK, to the dark depths of which we are now about to descend, is the most celebrated mine in the great mining county of Cornwall. It stands on the sea-coast, a little more than a mile to the north of St. Just. The region around it is somewhat bleak, and almost destitute of trees. In approaching it, the eyes of the traveller are presented with a view of engine-houses, and piles of stones and rubbish, in the midst of which stand a number of uncouth, yet picturesque, objects, composed of boards and timber, wheels, ropes, pulleys, chains, and such-like gear. These last are the winding erections of the shafts which lead to the various mines, for the whole region is undermined, and Botallack is only one of several in St. Just parish. Wherever the eye turns, there, in the midst of green fields, where rocks and rocky fences abound, may be seen, rising prominent, the labouring arms, or "bobs," of the pump and skip engines, and the other machinery required in mining operations; while the ear is assailed by the perpetual clatter of the "stamps," or ore-crushing machines, which never cease their din, day or night, except on Sundays.

Botallack, like all the other mines, has several "shafts" or entrances to the works below, such as Boscawen Shaft; Wheal Button; Wheal Hazard; Chicornish Shaft; Davis Shaft; Wheal Cock, etc., the most interesting of which are situated among the steep rugged cliffs that front and bid defiance to the utmost fury of the Atlantic Ocean.

From whatever point viewed, the aspect of Botallack mine is grand in the extreme. On the rocky point that stretches out into the sea, engines with all their fantastic machinery and buildings have been erected. On the very summit of the cliff is seen a complication of timbers, wheels and chains, sharply defined against the sky, with apparently scarce any hold of the cliff, while down below, on rocky ledges and in black chasms, are other engines and beams and rods and wheels and chains, fastened and perched in fantastic forms in dangerous-looking places.

Here, amid the most savage gorges of the sea and riven rocks,—half clinging to the land, half suspended over the water—is perched the machinery of and entrance to the most singular shaft of the mine, named the "Boscawen Diagonal Shaft." This shaft descends under the sea at a steep incline. It is traversed, on rails, by an iron carriage called the "gig," which is lowered and drawn up by steam power. Starting as it does from an elevated position in the rocks that are close to the edge of the sea, and slanting down through the cape, *outward* or seaward, this vehicle descends only a few fathoms when it is *under the ocean's bed*, and then its further course is far out and deep down—about two-thirds of a mile out, and full 245 fathoms down! The gig conveys the men to and from their work—the ore being drawn up by another iron carriage. There is (or rather there was, before the self-acting break was added) danger attending the descent of this shaft, for the rope, although good and strong, is not immaculate, as was proved terribly in the year 1864—when it broke, and the gig flew down to the bottom like lightning, dashing itself to pieces, and instantly killing the nine unfortunate men who were descending at the time.

Nevertheless, the Prince and Princess of Wales did not shrink from descending this deep burrow under the sea in the year 1865.

It was a great day for St. Just and Botallack, that 24th of July on which the Royal visit was paid. Great was the expectation and preparation on all hands to give a hearty welcome to the royal pair.

The ladies arrayed themselves in their best to do fitting honour to the Princess; the bal-maidens donned their holiday-attire, and Johnny Fortnight* took care, by supplying the poor mine-girls with the latest fashions, that their appearance should be, if we may be allowed the word, *splendiferous!* The Volunteers, too, turned out in force, and no one, looking at their trim, soldierly aspect, could have believed them to be the same miners who were wont to arise each evening through a hole in the earth, red as lobsters, wet, ragged, and befouled—in a word, surrounded by a halo of dishevelment, indicative of their rugged toils in the regions below.

Everywhere the people turned out to line the roads, and worthily receive the expected visitors, and great was the cheering when they arrived, accompanied by the Duke and Duchess of Sutherland, the Earl of Mount Edgecumbe, Lady de Grey, Lord and Lady Vivian, General Knollys, and others, but louder still was the cheer when the Princess rode down the steep descent to the cliffs in a donkey-carriage.

The Botallack cliffs themselves, however, were the central point, not only of the interest, but of the grandeur of the scene, for here was presented such a view and combination as are not often witnessed—

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* The packmen are so styled because of their visits being paid fortnightly.

nature in one of her wildest aspects, combined with innumerable multitudes of human beings swayed by one feeling of enthusiastic loyalty. Above, on every attainable point, projection, and eminence, men and women clustered like gay flies on the giant cliffs, leaving immense gaps here and there, where no foot might venture save that of a bird. Midway, on the face of the precipice, clung the great beams and supports of the Boscawen Diagonal Shaft, with the little gig perched on them and the Royal party seated therein, facing the entrance to the black abyss—the Princess arrayed in a white flannel cloak trimmed with blue, and a straw hat with a blue ribbon round it, and the Prince clad in miner's costume. Underneath, a dizzy depth to gaze down, lay the rugged boulders of the shore, with the spray of the Atlantic springing over them.

Deafening was the cheer when the gig at last entered the shaft and disappeared, and intense the anxiety of the vast multitude as they watched the descent—in imagination, of course, for nothing could be seen but the tight wire-rope uncoiling its endless length, and disappearing like a thin snake down the jaws of some awful sea-monster that had climbed so far up the cliffs to meet and devour it! Now they are at the shore; now passing under the sea; fairly under it by this time; a few minutes more and they have reached the spot where yonder sea-gull is now wheeling above the waves, wondering what new species of bird has taken possession of its native cliffs. Five minutes are passed—yet still descending rapidly! They must be half a mile out from the land now—half of a mile out on the first part of a submarine tunnel to America! "Old England is on the lee," but they are very much the reverse of afloat; solid rock is above, on either side and below—so close to them that the elbows must not be allowed to protrude over the edge of their car, nor the head be held too high. Here even Royalty must stoop—not that we would be understood to imply that Royalty cannot stoop elsewhere. Those who dwell in Highland cottages could contradict us if we did! Presently the rope "slows"—the lower depths are reached, and now for some time there is patient waiting, for it is understood that they are examining the "levels," where the stout men of Cornwall tear out the solid rock in quest of copper and tin.

After a time the thin snake begins to ascend: they are coming up now, but not so fast as they went down. It is about ten minutes before the gig emerges from that black hole and bears the Prince and Princess once more into the light of day.

Yes, it was a great day for Botallack, and it will dwell long in the memories of those who witnessed it—especially of that fortunate Captain of the mine who had the honour of conducting the Princess on the occasion, and of whose enthusiasm in recalling the event, and in commenting on her intelligence and condescension, we can speak from personal observation.

But, reader, you will say, What has all this to do with your story?

Nothing—we admit it frankly—nothing whatever in a direct way; nevertheless, indirectly, the narrative may possibly arouse in you greater interest in the mine down which we are about to conduct you—not by the same route as that taken by the Prince and Princess (for the Boscawen shaft did not exist at the period of our tale), but by one much more difficult and dangerous, as you shall see.

Before we go, however, permit us to add to the offence of digression, by wandering still further out of our direct road. There are a few facts regarding Botallack and mining operations, without a knowledge of which you will be apt at times to misunderstand your position.

Let us suppose that a mine has been already opened; that a "lode," *i.e.*, a vein of quartz with metal in it, has been discovered cropping out of the earth, and that it has been dug down upon from above, and dug in upon from the sea-cliffs. A shaft has been sunk—in other words, a hole excavated—let us say, two or three hundred yards inland, to a depth of some forty or fifty fathoms,—near the sea level. This shaft is perhaps nine feet by six wide. The lode, being a layer of quartz, sometimes slopes one way, sometimes another, and is occasionally perpendicular. It also varies in its run or direction a little here and there, like a wildish horse, being sometimes met by other lodes, which, like bad companions, divert it from the straight course. Unlike bad companions, however, they increase its value at the point of meeting by thickening it. Whatever course the lode takes, the miner conscientiously follows suit. His shaft slopes much, little, or not at all, according to the "lie of the lode."

It is an ancient truism that water must find its level. Owing to this law, much water accumulates in the shaft, obliging the miner to erect an engine-house and provide a powerful pumping-engine with all its gear, at immense cost, to keep the works dry as he proceeds. He then goes to the shore, and there, on the face of the perpendicular cliff, a little above the sea level, he cuts a horizontal tunnel about six feet high by three broad, and continues to chisel and blast away the solid rock until he "drives" his tunnel a quarter of a mile inland, which he will do at a rate varying from two to six feet per week, according to the hardness of the rock, until he reaches the shaft and thus provides an easy and inexpensive passage for the water without pumping. This tunnel or level he calls the "Adit level." But his pumping-engine is by no means rendered useless, for it has much to do in hauling ore to the surface, etc. In process of time, the miner works away all the lode down to the sea-level, and must sink the shaft deeper—perhaps ten or twenty fathoms,—where new levels are driven horizontally "on the lode," and water accumulates which must be pumped up to the Adit level, whence it escapes to the sea.

Thus down, down, he goes, sinking his shaft and driving his levels on—that is, always following—the lode *ad infinitum.* Of course he must stop before reaching the other side of the world! At the present time Botallack has progressed in that direction to a depth of 245 fathoms. To those who find a difficulty in realizing what depth that really is, we would observe that it is equal to more than three and a half times the height of St. Paul's Cathedral in London, nearly four times the height of St. Rollox chimney in Glasgow, and considerably more than twice the height, from the plain, of Arthur's Seat, near Edinburgh.

When the levels have been driven a considerable distance from the shaft, the air naturally becomes bad from want of circulation. To remedy this evil, holes, or short shafts, called "winzes," are sunk at intervals from the upper to the lower levels. These winzes are dangerous traps for the unwary or careless, extending frequently to a depth of ten or fifteen fathoms, and being bridged across by one or two loose planks. Ladders are fixed in many of them to facilitate progress through the mine. When a miner drives the end of his level so far that the air will not circulate, a new winze is usually sunk down to him from the level above. The circulation is thus extended, and the levels progress farther and farther right and left until they occupy miles of ground. The levels and shafts of Botallack, if put together, would extend to not less than forty miles, and the superficial space of ground, on and beneath which the mine lies, is above 260 acres.

When the lode is rich and extends upwards or downwards, it is cut away from between levels, in a regular systematic manner, strong beams being placed to support temporary platforms, on which the miners may stand and work as they ascend. When they have cut all the lode away up to the level above them, a false timber bottom is made to replace the rocky bottom of the level which is being removed. Thus, in traversing the old workings of a mine one suddenly comes to great caverns, very narrow, but of such immense height above and depth below, that the rays of your candle cannot penetrate the darkness. In such places the thick short beams that were used by the old miners are seen extending from side to side of the empty space, disappearing in dim perspective. Woe betide the man who stumbles off his narrow plank, or sets his foot on an insecure beam in such places! Where such workings are in progress, the positions of the miners appear singularly wild and insecure. The men stand in the narrow chasm between the granite walls above each others' heads, slight temporary platforms alone preserving them from certain death, and the candles of those highest above you twinkling like stars in a black sky.

In these underground regions of Botallack, above three hundred men and boys are employed, some of whom work occasionally by night as well as by day. On the surface about two hundred men, women, and boys are employed "dressing" the ore, etc.

Other mines there are in the great mining centres of Cornwall,—Redruth, St. Just, St. Austell, and Helston, which are well worthy of notice—some of them a little deeper, and some richer than Botallack. But we profess not to treat of all the Cornish mines: our object is to describe one as a type of many, if not all, and as this one runs furthest out beneath the sea, is deeper than most of the others, and richer than many, besides having interesting associations, and being of venerable antiquity, we hold it to be the one most worthy of selection.

With a few briefly stated facts we shall take final leave of statistics.

As we have said, the Boscawen shaft measures 245 fathoms. The ladder-way by which the men ascend and descend daily extends to 205 fathoms. It takes a man half-an-hour to reach the bottom, and fully an hour to climb to the surface. There are three pumping and seven winding engines at work—the largest being of 70 horse power. The tin raised is from 33 to 35 tons a month. The price of tin has varied from £55 to £90 per ton. In time past, when Botallack was more of a copper than a tin mine, a fathom has been known to yield £100 worth of ore, and a miner has sometimes broken out as much as £300 worth in one month.

The mine has been worked from time immemorial. It is known to have been wrought a hundred years before it was taken by the present company, who have had it between thirty and forty years, and, under the able direction of the present manager and purser, Mr. Stephen Harvey James, it has paid the shareholders more than £100,000. The profit in the year 1844 was £24,000. At the termination of one period of working it left a profit of £300,000. It has experienced many vicissitudes of fortune. Formerly it was worked for tin, and at one period (1841) was doing so badly that it was about to be abandoned, when an unlooked-for discovery of copper was made, and a period of great prosperity again set in, during which many shareholders and miners made their fortunes out of Botallack.

Thus much, with a humble apology, we present to the reader, and now resume the thread of our narrative.

CHAPTER VIII.

DOWN, DOWN, DOWN.

BEFORE descending the mine Captain Dan led Oliver to the counting-house, where he bade him undress and put on miner's clothing.

"I'll need a biggish suit," observed Oliver.

"True," said Captain Dan; "we are obliged usually to give visitors our smallest suits. You are an exception to the rule. Indeed, I'm not sure that I have a pair of trousers big enough for—ah yes, by the way, here are a pair belonging to one of our Captains who is unusually stout and tall; I daresay you'll be able to squeeze into 'em."

"All right," said Oliver, laughing, as he pulled on the red garments; "they are wide enough round the waist, at all events. Now for a hat."

"There," said the Captain, handing him a white cotton skull-cap, "put that on."

"Why, what's this for?" said Oliver.

"To keep *that* from dirtying your head," replied the other, as he handed his companion a thick felt hat, which was extremely dirty, on the front especially, where the candle was wont to be fixed with wet clay. "Now, then, attach these two candles to that button in your breast, and you are complete.—Not a bad miner to look at," said Captain Dan with a smile of approval.

The Captain was already equipped in underground costume, and the dirty disreputable appearance he presented was, thought Oliver, a wonderful contrast to his sober and gentlemanly aspect on the evening of their first meeting at his uncle's table.

"I'll strike a light after we get down a bit—so come along," said Captain Dan, leaving the office and leading the way.

On reaching the entrance to the shaft, Oliver Trembath looked down and observed a small speck of bright light in the black depths.

"A man coming up—wait a bit," said the Captain in explanation.

Presently a faint sound of slow footsteps was heard; they grew gradually more distinct and ere long the head and shoulders of a man emerged from the hole. Perspiration was trickling down his face, and painting him, streakily, with iron rust and mud. All his garments were soaking. He sighed heavily on reaching the surface, and appeared to inhale the fresh air with great satisfaction.

"Any more coming?"

"No, Captain Dan," replied the man, glancing with some curiosity at the tall stranger.

"Now, sir, we shall descend," said the Captain, entering the shaft.

Oliver followed, and at once plunged out of bright sunshine into subdued light. A descent of a few fathoms brought them to the bottom of the first ladder. It was a short one; most of the others, the Captain told him, were long ones. The width of the shaft was about six feet by nine. It was nearly perpendicular, and the slope of the ladders corresponded with its width—the head of each resting against one side of it, and the foot against the other, thus forming a zig-zag of ladders all the way down.

At the foot of the first ladder, the light was that of deep twilight. Here was a wooden platform, and a hole cut through it, out of which protruded the head of the second ladder. The Captain struck a light, and, applying it to one of the candles, affixed the same to the front of Oliver's hat. Arranging his own hat in a similar way, he continued the descent, and, in a few minutes, both were beyond the region of daylight. When they had got a short way down, probably the distance of an ordinary church-steeple's height below the surface, Oliver looked up and saw the little opening far above him, shining brightly like a star. A few steps more and it vanished from view: he felt that he had for the first time in his life reached the regions of eternal night.

The shaft varied in width here and there; in most places it was very narrow,—about six feet wide—but, what with cross-beams to support the ides, and prevent soft parts from falling in, and other obstructions, the space available for descent was often not more than enough to permit of a man squeezing past.

A damp smell pervaded the air, and there was a strange sense of contraction and confinement, so to speak, which had at first an unpleasant effect on Oliver. The silence, when both men paused at a ladder-foot to trim candles or to rest a minute, was most profound, and there came over the young doctor a sensation of being buried alive, and of having bid a final farewell to the upper earth, the free air, and the sunshine, as they went down, down, down to the depths below.

At last they reached a "level" or gallery, by which the ladder-shaft communicated with the pump-shaft.

Here Captain Dan paused and trimmed Oliver's candle, which he had thrust inadvertently against a beam, and broken in two.

"You have to mind your head here, sir," said the

Captain, with a quiet smile; "'tis a good place to learn humility."

Oliver could scarce help laughing aloud as he gazed at his guide, for, standing as he did with the candle close to his face, his cheeks, nose, chin, forehead, and part of the brim of his hat and shoulders were brought into brilliant light, while the rest of him was lost in the profound darkness of the level behind, and the flame of his candle rested above his head like the diadem of some aristocratic gnome.

"How far down have we come?" inquired Oliver.

"About eighty fathoms," said the Captain; "we shall now go along this level and get into the pump-shaft, by which we can descend to the bottom. Take care of your feet and head as you go, for you'll be apt to run against the rocks that hang down, and the winzes are dangerous."

"And pray what are winzes?" asked Oliver as he stumbled along in the footsteps of his guide, over uneven ground covered with *débris.*—"Ah! hallo! stop!"

"What's wrong?" said the Captain, looking back, and holding up his candle to Oliver's face.

"Candle gone again, Captain; I've run my head on that rock. Lucky for me that your mining hats are so thick and hard, for I gave it a butt that might have done credit to an ox."

"I told you to mind your head," said Captain Dan, relighting the candle; "you had better carry it in your hand in the levels, it will light your path better. Look out now—here is a winze."

The Captain pointed to a black yawning hole, about six or seven feet in diameter, which was bridged across by a single plank.

"How deep does it go?" asked the youth, holding up his candle and peering in; "I can't see the bottom."

"I daresay not," said the Captain, "for the bottom is ten fathoms down, at the next level."

"And are all the winzes bridged with a single plank in this way?"

"Why, no, some of 'em have two or three planks, but they're quite safe if you go steady."

"And, pray, how many such winzes are there in the mine?" asked Oliver.

"Couldn't say exactly, without thinkin' a bit," replied the Captain, "but there are a great number of 'em—little short of a hundred I should say—for we have a good many miles of levels in Botallack, which possesses an underground geography as carefully measured and mapped out as that of the surface."

"And what would happen," asked Oliver, with an expression of half-simulated anxiety, "if you were to fall down a winze and break your neck, and my candle were to get knocked or blown out, leaving me to find my way out of a labyrinth of levels, pierced with holes sixty feet deep?"

"Well, it's hard to say," replied Captain Dan with much simplicity.

"Go on," said Oliver, pursing his lips with a grim smile, as he followed his leader across the narrow bridge.

Captain Dan continued his progress until he reached the pump-shaft, the proximity of which was audibly announced by the slow ascent and descent of a great wooden beam, which was styled the "pump-rod." Alongside, and almost touching it, for space was valuable there, and had to be economized, was the iron pipe—nearly a foot in diameter—which conveyed the water from the mine to the "Adit level."

The slow-heaving plunge, of about ten feet in extent, and the sough or sigh of the great beam, with the accompanying gurgle of water in the huge pipe, were sounds that seemed horribly appropriate to the subterranean scene. One could have imagined the mine to be a living giant in the last throes of death by drowning. But these were only one half of the peculiarities of the place. On the other side of the shaft an arrangement of beams and partially broken boards formed the traversing "ways" or tube, up which were drawn the kibbles,—these last being large iron buckets used for lifting ore to the surface.

In the present day, machinery being more perfect, the ancient kibble has been to some extent supplanted by skips, or small trucks with wheels (in some cases iron boxes with guiding-rods), which are drawn up smoothly, and without much tear and wear; but in the rough times of which we write, the sturdy kibble used to go rattling up the shaft with deafening noise, dinting its thick sides, and travelling with a jovial free-and-easy swing that must have added considerably to the debit side of the account of working expenses. Between the pump-rod and the kibble-way there was just room for the ladders upon which Captain Dan, followed by Oliver, now stepped. This shaft was very wet, water dropped and spirted about in fine spray everywhere, and the rounds of the ladders were wet and greasy with much-squeezed slime.

It would seem as though the kibbles had known that a stranger was about to descend and had waited for him, for no sooner did Oliver get on the ladder than they began to move,—the one to ascend full, and the other to descend empty.

"What's that?" exclaimed Oliver.

"It's only the kibbles," replied Captain Dan.

Before the Captain could explain what kibbles were, these reckless buckets met, with a bang, close to Oliver's cheek, and rebounded on the beams, that protected him from their fury. Naturally the young man shrank a little from a noise so loud and so near. He was at once scraped down on the other side by the pump-rod! Drawing himself together as much as possible, and feeling for once the disadvantage of being a large man, he followed his leader down, down, ever down, into the profounder depths below.

All this time they had not met with a miner, or with any sign of human life—unless the pump and kibbles could be regarded as such—for they had been hitherto traversing the old levels and workings of the mine, but at last, during one of their pauses, they heard the faint sound of chip, chip, chip, in the far distance.

"Miners?" inquired Oliver.

Captain Dan nodded, and said they would now leave the shaft and go to where the men were at work. He cautioned his companion again to have regard to his head, and to mind his feet. As they proceeded, he stopped ever and anon to point out some object of peculiar interest.

"There's a considerable space above and below you here, sir," said the Captain, stopping suddenly in a level which was not more than three feet wide.

Oliver had been so intent on his feet, and mindful of the winzes, that he had failed to observe the immense black opening overhead. It extended so high above him, and so far forward and backward in the direction of the level, that its boundaries were lost in an immensity of profoundly dark space. The rocky path was also lost to view, both before and behind them, so that the glare of their lights on the metallic walls rendered the spot on which they stood a point of brilliancy in the midst of darkness. Only part of a great beam was visible here and there above them, as if suspended in the gloom to render its profundity more apparent.

This, Captain Dan explained, was the space that had once been occupied by a rich lode of ore, all of which had been removed years ago, to the great commercial advantage of a past generation.

Soon after passing this the Captain paused at a deep cutting in the rock, and, looking sadly at it for a few minutes, said—

"It was here that poor Trevool lost his life. He was a good lad, but careless, and used to go rattling along the levels with his light in his hat and his thoughts among the stars, instead of carrying the light in his hand and looking to his feet. He fell down that winze and broke his back. When we got him up to grass he was alive, but he never spoke another word, and died the same night."

"Poor fellow!" said Oliver; "I suppose your men have narrow escapes sometimes."

"They have, sir, but it's most always owin' to carelessness. There was a cousin of that very lad Trevool who was buried with a comrade by the falling in of a shaft and came out alive. I was there at the time and helped to dig him out."

Captain Dan here stopped, and, sticking his candle against the wet wall of the mine, sat down on a piece of rock, while our hero stood beside him. "You see," said he, "we were sinking a shaft, or rather reopening an old one, at the time, and Harvey, that was the man's name, was down working with a comrade. They came to a soft bit o' ground, an' as they cut through it they boarded it up with timbers across to prevent it slipping, but they did the work hastily. After they had cut down some fathoms below it, the boarding gave way, and down the whole thing went, boards, timbers, stones, and rubbish, on their heads. We made sure they were dead, but set to, nevertheless, to dig them out as fast as possible—turning as many hands to the work as could get at it. At last we came on them, and both were alive, and not very much hurt! The timbers and planks had fallen over them in such a way as to keep the stones and rubbish off. I had a talk with old Harvey the other day on this very subject. He told me that he was squeezed flat against the side of the shaft by the rubbish which buried him, and that he did not lose consciousness for a moment. A large stone had stuck right above his head, and this probably saved him. He heard us digging down to him, he said, and when we got close he sang out to hold on, as the shovel was touching him. Sure enough this was the case, for the next shovelful of rubbish that was lifted revealed the top of his head! We cleared the way to his mouth as carefully as we could, and then gave him a drop of brandy before going on with the work of excavation. His comrade was found in a stooping position, and was more severely bruised than old Harvey, but both of them lived to tell the tale of their burial, and to thank God for their deliverance. Yes," continued the Captain, detaching his candle from the wall and resuming his walk, "we have narrow escapes sometimes.—Look here, doctor, did you ever see a rock like that?"

Captain Dan pointed to a place in the side of the rocky wall which was grooved and cut as if with a huge gouge or chisel, and highly polished. "It was never cut by man in that fashion; we found it as you see, and there's many of 'em in the mine. We call 'em slinking slides."

"The marks must have been caused when the rocks were in a state of partial fusion," observed Oliver, examining the place with much curiosity.

"I don't know as to that, sir," said the Captain, moving on, "but there they are, and some of 'em polished to that extent you could almost see your face in 'em."

On turning the corner of a jutting rock a light suddenly appeared, revealing a pair of large eyes and a double row of teeth, as it were gleaming out of the darkness. On drawing nearer this was discovered to be a miner, whose candle was at some little distance, and only shone on him partially.

"Well, Jack, what's doing?" asked the Captain.

The man cast a disconsolate look on a large mass of rock which lay in the middle of the path at his feet. He had been only too successful in his last blasting, and had detached a mass so large that he could not move it.

"It's too hard for to break, Captain Dan."

"Better get it into the truck," said the Captain.

"Can't lift it, sur," said the man, who grudged to go through the tedious process of boring it for a second blast.

"You must get it out o' that, Jack, at all events. It won't do to let it lie there," said the Captain, passing on, and leaving the miner to get out of his difficulty as best he might.

A few minutes more and they came on a "pare" of men (in other words, a band of two or more men working together) who were "stoping-in the back of the level," as they termed the process of cutting upwards into the roof.

"There's a fellow in a curious place!" said Oliver, peering up through an irregular hole, in which a man was seen at work standing on a plank supported by a ladder. He was chiselling with great vigour at the rock over his head, and immediately beyond him another man stood on a plank supported by a beam of timber, and busily engaged in a similar occupation. Both men were stripped to the waist, and panted at their toil. The little chamber or cavern in which they worked was brilliantly illuminated by their two candles, and their athletic figures stood out, dark and picturesque, against the light glistering walls.

"A curious place, and a singular man!" observed the Captain; "that fellow's family is not a small one.—Hallo! James Martin."

"Hallo! Captain Dan," replied the miner, looking down.

"How many children have you had?"

"How many child'n say 'ee?"

"Ay, how many?"

"I 've had nineteen, sur, an' there 's eight of 'em alive. Seven of 'em came in three year an' six month, sur—three doubles an' a single, but them uns are all gone dead, sur."

"How old are you, Jim?"

"Forty-seven, sur."

"Your brother Tom is at work here, isn't he?"

"Iss, in the south level, drivin' the end."

"How many children has Tom, Jim?"

"Seventeen, sur, an' seven of em's alive; but Tom 's only thirty-eight year old, sur."*

"Good morning, Jim."

"Good morning, Captain Dan," replied the sturdy miner, resuming his work.

"Good specimens of men these," said the Captain, with a quiet smile, to Oliver. "Of course I don't mean to say that all the miners hereabouts are possessed of such large families—nevertheless there are, as I daresay you have observed, a good many children in and about St. Just!"

Proceeding onward they diverged into a branch level, where a number of men were working overhead; boring holes into the roof and burrowing upwards. They all drove onwards through flinty rock by the same slow and toilsome process that has already been described—namely, by chipping with the pick, driving holes with the borer, and blasting with gunpowder.

As the Captain and Oliver traversed this part of the mine they had occasionally to squeeze past small iron trucks which stood below holes in the sides of the level, down which ever and anon masses of ore and *débris* came from the workings above with a hard crashing noise. The ore was rich with tin, but the metal was invisible to any but trained eyes. To Oliver Trembath the whole stuff appeared like wet rubbish.

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* Reader, allow us to remark that this is a fact. Indeed, we may say here, once for all, that all the *important* statements and incidents in this tale are facts, or founded on facts, with considerable modification, but without intentional exaggeration.

Suddenly a low muffled report echoed through the cavernous place. It was followed by five or six similar reports in succession.

"They are blasting," said Captain Dan.

As he spoke, the thick muddy shoes and brick-dust legs of a man appeared coming down the hole that had previously discharged ore. The man himself followed his legs, and, alighting thereon, saluted Captain Dan with a free-and-easy "Good-morning." Another man followed him; from a different part of the surrounding darkness a third made his appearance, and others came trooping in, until upwards of a dozen of them were collected in the narrow tunnel, each with his tallow-candle in his hand or hat, so that the place was lighted brilliantly. They were all clad in loose, patched, and ragged clothes. All were of a uniform rusty-red colour, each with his broad bosom bared, and perspiration trickling down his besmeared countenance.

Here, however, the uniformity of their appearance ended, for they were of all sizes and characters. Some were robust and muscular; some were lean and wiry; some were just entering on manhood, with the ruddy hue of health shining through the slime on their smooth faces; some were in the prime of life, pale from long working under ground, but strong and almost as hard as the iron with which they chiselled the rocks. Others were growing old, and an occasional cough told that the "miners' complaint" had begun its fatal undermining of the long-enduring, too-long tried human body. There were one or two whose iron constitutions had resisted the evil influences of wet garments, bad air and chills, and who, with much of the strength of manhood, and some of the colour of youth, were still plying their hammers in old age. But these were rare specimens of vigour and longevity; not many such are to be found in Botallack mine. The miner's working life is a short one, and comparatively few of those who begin it live to a healthy old age. Little boys were there, too, diminutive but sturdy urchins, miniature copies of their seniors, though somewhat dirtier; proud as peacocks because of being permitted at so early an age to accompany their fathers or brothers underground, and their bosoms swelling with that stern Cornish spirit of determination to face and overcome great difficulties, which has doubtless much to do with the excessive development of chest and shoulder for which Cornish miners, specially those of St. Just, are celebrated.*

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* It has been stated to us recently by a Volunteer officer, that at battalion parade, when companies were equalized in numbers, the

It turned out that the men had all arranged to fire their holes at the same hour, and assemble in a lower level to take lunch, or, as they term it, "kroust," while the smoke should clear away. This rendered it impossible for the Captain to take his young companion farther into the workings at that part of the mine, so they contented themselves with a chat with the men. These sat down in a row, and, each man unrolling a parcel containing a pasty or a thick lump of cake with currants in it, commenced the demolition thereof with as much zeal as had previously been displayed in the demolition of the rock. This frugal fare was washed down with water drawn from little flat barrels or canteens, while they commented lightly, grumblingly, or laughingly, according to temperament, on the poor condition of the lode at which they wrought. We have already said that in mining, as in other things, fortune fluctuates, and it was "hard times" with the men of Botallack at that period.

Before they had proceeded far with their meal, one of the pale-faced men began to cough.

"Smoke's a-comin' down," he said.

"We shall 'ave to move, then," observed another.

The pouring in of gunpowder smoke here set two

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companies formed by the men of St. Just required about four paces more space to stand upon than the other Volunteers. No one who visits a St. Just miner at his underground toil will require to ask the reason why!

or three more a-coughing, and obliged them all to rise and seek for purer—perhaps it were better to say less impure—air in another part of the level, where the draught kept the smoke away. Here, squatting down on heaps of wet rubbish, and sticking their candles against the damp walls, they continued their meal, and here the Captain and Oliver left them, retraced their steps to the foot of the shaft, and began the ascent to the surface, or, in mining parlance, began to "return to grass."

Up, up, up—the process now was reversed, and the labour increased tenfold. Up they went on these nearly perpendicular and interminable ladders, slowly, for they had a long journey before them; cautiously, for Oliver had a tendency to butt his head against beams, and knock his candle out of shape; carefully, for the rounds of the ladders were wet and slimy and a slip of foot or hand might in a moment have precipitated them into the black gulf below; and pantingly, for strength of limb and lung could not altogether defy the influence of such a prolonged and upright climb.

If Oliver Trembath felt, while descending, as though he should *never* reach the bottom, he felt far more powerfully as if reaching the top were an event of the distant future—all the more that the muscles of his arms and legs, unused to the peculiar process, were beginning to feel rather stiff. This feeling, however, soon passed away, and when he began to grow warm to the work, his strength seemed to return and to increase with each step—a species of revival of vigour in the midst of hard toil with which probably all strong men are acquainted.

Up they went, ladder after ladder, squeezing through narrow places, rubbing against wet rocks and beams, scraping against the boarding of the kibble-shaft, and being scraped by the pump-rods until both of them were as wet and red and dirty as any miner below.

As he advanced, Oliver began to take note of the places he had passed on the way down, and so much had he seen and thought during his sojourn underground, that, when he reached the level where he first came upon the noisy kibble, and made acquaintance with the labouring pump-rod, he almost hailed the spot as an old familiar landmark of other days!

A circumstance occurred just then which surprised him not a little, and tended to fix this locality still more deeply on his memory. While he was standing in the level, waiting until the Captain should re-light and trim his much and oft-bruised candle, the kibbles began their noisy motion. This was nothing new now, but at the same time the shout of distant voices was heard, as if the gnomes held revelry in their dreary vaults. They drew gradually nearer, and Oliver could distinguish laughter mingled with the sound of rapidly approaching footsteps.

"Foolish lads!" ejaculated Captain Dan, with a smile, and an expression that proved he took some interest in the folly, whatever it might be.

"What is it?" inquired Oliver.

"They are racing to the kibble. Look and you shall see," replied the other.

Just then a man who had outrun his comrades appeared at the place where the level joined the shaft, just opposite. Almost at the same moment the kibble appeared flying upwards. The miner leaped upon it, caught and clung to the chain as it passed, and shouted a defiant adieu to his less fortunate comrades, who arrived just in time to witness him disappear upwards in this rapid manner "to grass."

"That's the way the young ones risk their lives," said the Captain, shaking his head remonstratively; "if that young fellow had missed the kibble he would have been dashed to pieces at the bottom of the shaft."

Again Captain Dan said "Foolish lads," and shook his head so gravely that Oliver could not help regarding him with the respect due to a sedate fatherly sort of man—but Oliver was young and unsophisticated and did not know at the time that the

Captain had himself been noted in his youth as an extremely reckless and daring fellow, and that a considerable spice of the daring remained in him still!

Diverging to the right at this point Captain Dan led Oliver to an old part of the mine, where there were a couple of men opening up and extending one of the old levels. Their progress here was very different from what it had been. Evidently the former miners had not thought it worth their while to open up a wide passage for themselves, and Oliver found it necessary to twist his broad shoulders into all sorts of positions to get them through.

The first level they came to in this part was not more than three feet high at the entrance.

"A man can't hold his head very high here, sir," said his guide.

"Truly no, it is scarce high enough for my legs to walk in without any body above them," said Oliver. "However, lead the way, and I will follow."

The Captain stooped and made his way through a winding passage where the roof was so low in many places that they were obliged to bend quite double, and the back and neck of the young doctor began to feel the strain very severely. There were, however, a few spots where the roof rose a little, affording temporary relief. Presently they came to the place where the men were at work. The ground was very soft here; the men were cutting through *soft* granite!—a condition of the stone which Oliver confessed he had never expected to see. Here the lights burned very badly.

"What can be the matter with it?" said Oliver, stopping for the third time to trim the wick of his candle.

Captain Dan smiled as he said, "You asked me, last night, to take you into one of the levels where the air was bad—now here you are, with the air so bad that the candle will hardly burn. It will be worse before night."

"But I feel no disagreeable sensation," said Oliver.

"Possibly not, because you are not quite so sensitive as the flame of a candle, but if you remain here a few hours it will tell upon you. Here are the men—you can ask them."

The two men were resting when they approached. One was old, the other middle-aged. Both were hearty fellows, and communicative. The old one, especially, was ruddy in complexion and pretty strong.

"You look well for an old miner," said Oliver; "what may be your age?"

"About sixty, sur."

"Indeed! you are a notable exception to the rule. How comes it that you look so fresh?"

"Can't say, sur," replied the old man, with a peculiar smile; "few miners live to my time of life, much less do they go underground. P'raps it's because I neither drink nor smoke. Tom there, now," he added, pointing to his comrade with his thumb, "he ain't forty yit, but he's so pale as a ghost! though he is strong 'nuff."

"And do you neither drink nor smoke, Tom?" inquired Oliver.

"Well, sur, I both smokes and drinks, but I do take 'em in moderation," said Tom.

"Are you married?" asked Oliver, turning again to the old man.

"Iss, got a wife at hum, an' had six child'n."

"Don't you find this bad air tell on your health?" he continued.

"Iss, sure. After six or seven hours I do feel my head like to split, an' my stummik as if it wor on fire,—but what can us do? we must live, you knaw."

Bidding these men goodbye, the Captain and Oliver went down to another level, and then along a series of low galleries, in some of which they had to advance on their hands and knees, and in one of them, particularly, the accumulation of rubbish was so great, and the roof so low, that they could only force a passage through by wriggling along at full length like snakes. Beyond this they found a miner and a little boy at work; and here Captain Dan pointed out to his companion that the lodes of copper and tin were rich. Glittering particles on the walls and drops of water hanging from points and crevices, with the green, purple, and yellow colours around, combined to give the place a brilliant metallic aspect.

"You'd better break off a piece of ore here," said Captain Dan.

Oliver took a chisel and hammer from the miner, and applying them to the rock, spent five minutes in belabouring it with scarcely any result.

"If it were not that I fear to miss the chisel and hit my knuckles," he said, "I think I could work more effectively."

As he spoke he struck with all his force, and brought down a large piece, a chip of which he carried away as a memorial of his underground ramble.

"The man is going to fire the hole," said Captain Dan; "you'd better wait and see it."

The hole was sunk nearly two feet deep diagonally behind a large mass of rock that projected from the side of the level. It was charged with gunpowder, and filled up with "tamping" or pounded granite. Then the miner lighted the fuse and hastened away, giving the usual signal, "Fire!" The others followed him to a safe distance, and awaited the result. In a few minutes there was a loud report, a bright blinding flash, and a concussion of the air, which extinguished two of the candles. Immediately a crash followed, as the heavy mass of rock was torn from its bed and hurled to the ground.

"That's the way we raise tin and copper," said Captain Dan; "now, doctor, we had better return, if you would not be left in darkness, for our candles are getting low."

"Did you ever travel underground in the dark?" inquired Oliver.

"Not often, but I have done it occasionally. Once, in particular, I went down the main shaft in the dark, and gave a miner an awful fright. I had to go down in haste at the time, and, not having a candle at hand, besides being well acquainted with the way, I hurried down in the dark. It so chanced that a man named Sampy had got his light put out when about to ascend the shaft, and, as he also was well acquainted with the way, he did not take the trouble to relight. There was a good deal of noise in consequence of the pump being at work. When I had got about half-way down I put my foot on something that felt soft. Instantly there was uttered a tremendous yell, and my legs at the same moment were seized by something from below. My heart almost jumped out of my mouth at this, but as the yell was repeated it flashed across me I must have trod on some one's fingers, so I lifted my foot at once, and then a voice, which I knew to be that of Sampy, began to wail and lament miserably.

"'Hope I haven't hurt 'ee, Sampy?' said I.

"'Aw dear! aw dear! aw, my dear!' was all that poor Sampy could reply.

"'Let us go up, my son,' said I, 'and we'll strike a light.'

"So up we went to the next level, where I got hold of the poor lad's candle and lighted it.

"'Aw my dear!' said Sampy, looking at his fingers with a rueful countenance; 'thee have scat 'em all in jowds.'"

"Pray," interrupted Oliver, "what may be the meaning of 'scat 'em all in jowds'?"

"Broke 'em all in pieces," replied Captain Dan; "but he was wrong, for no bones were broken, and the fingers were all right again in the course of a few days. Sampy got a tremendous fright, however, and he was never known to travel underground without a light after that."

Continuing to retrace their steps, Captain Dan and Oliver made for the main shaft. On the way they came to another of those immense empty spaces where a large lode had been worked away, and nothing left in the dark narrow void but the short beams which had supported the working stages of the men. Here Oliver, looking down through a hole at his feet, saw several men far below him. They were at work on the "end" in three successive tiers—above each other's heads.

"You've seen two of these men before," said Captain Dan.

"Have I?"

"Yes, they are local preachers. The last time you saw the upper one," said Captain Dan, with a smile, "you were seated in the Wesleyan chapel, and he was in the pulpit dressed like a gentleman, and preaching as eloquently as if he had been educated at college, and trained for the ministry."

"I should like very much to go down and visit them," said Oliver.

"'Tis a difficult descent. There are no ladders. Will your head stand stepping from beam to beam and can you lower yourself by a chain?"

"I'll try," said Oliver.

Without more words Captain Dan left the platform on which they had been walking, and, descending through a hole, led his companion by the most rugged way he had yet attempted. Sometimes they slid on their heels down places that Oliver would not have dreamed of attempting without a guide; at other times they stepped from beam to beam, with unknown depths below them.

"Have a care here, sir," said the Captain, pausing before a very steep place. "I will go first and wait for you."

So saying, he seized a piece of old rusty chain that was fastened into the rock, and swung himself down. Then, looking up, he called to Oliver to follow.

The young doctor did so, and, having cautiously lowered himself a few yards, he reached a beam, where he found the Captain holding up his candle, and regarding him with some anxiety. Captain Dan appeared as if suspended in mid-air. Opposite to him, in the distance, the two "local preachers" were hard at work with hammer and chisel, while far below, a miner could be seen coming along the next level, and pushing an iron truck full of ore before him.

A few more steps and slides, and then a short ascent, and Oliver stood beside the man who had preached the previous Sunday. He worked with another miner, and was red, ragged, and half-clad, like all the rest, and the perspiration was pouring over his face, which was streaked with slime. Very unlike was he at that time to the gentlemanly youth who had held forth from the pulpit. Oliver had a long chat with him, and found that he aspired to enter the ministry, and had already passed some severe examinations. He was self-taught, having procured the loan of books from his minister and some friends who were interested in him. His language and manners were those of a gentleman, yet he had had no advantages beyond his fellows.

"My friend there, sir, also hopes to enter the ministry," said the miner, pointing, as he spoke, to a gap between the boards on which he stood.

Oliver looked down, and there beheld a stalwart young man, about a couple of yards under his feet, wielding a hammer with tremendous vigour. His light linen coat was open, displaying his bared and muscular bosom.

"What! is *he* a local preacher also?"

"He is, sir," said the miner, with a smile.

Oliver immediately descended to the stage below, and had a chat with this man also, after which he left them at their work, wondering very much at the intelligence and learning displayed by them, for he remembered that in their sermons they had, without notes, without hesitation, and without a grammatical error, entered into the most subtle metaphysical reasoning, (rather too much of it indeed!) and had preached with impassioned (perhaps too impassioned) eloquence, quoting poets and prose writers, ancient and modern, with the facility of good scholars—while they urged men and women to repent and flee to Christ, with all the fervour of men thoroughly in earnest. On the other hand, he knew that their opportunities for self-education were not great, and that they had to toil in the meantime for daily bread, at the rate of about £3 a month!

Following Captain Dan, Oliver soon reached the ladder-way.

While slowly and in silence ascending the ladders, they heard a sound of music above them.

"Men coming down to work, singing," said the Captain, as they stood on a cross-beam to listen.

The sounds at first were very faint and inexpressibly sweet. By degrees they became more distinct, and Oliver could distinguish several voices singing in harmony, keeping time to the slow measured tread of their descending steps. There seemed a novelty, and yet a strange familiarity, in the strains as they were wafted softly down upon his ear, until they drew near, and the star-like candles of the miners became visible. Their manly voices then poured forth in full strength the glorious psalm-tune called "French," which is usually sung in Scotland to the beautiful psalm beginning "I to the hills will lift mine eyes."

The men stopped abruptly on encountering their Captain and the stranger. Exchanging a few words with the former, they stood aside on the beams to let them pass. A little boy came last. His small limbs were as active as those of his more stalwart comrades, and he exhibited no signs of fatigue

His treble voice, too, was heard high and tuneful among the others as they continued their descent and resumed the psalm. The sweet strains retired gradually, and faded in the depths below as they had first stolen on the senses from above; and the pleasant memory of them still remained with the young doctor when he emerged from the mine through the hole at the head of the shaft, and stood once more in the blessed sunshine!

CHAPTER IX.

TREATS OF DIFFICULTIES TO BE OVERCOME.

One afternoon a council—we may appropriately say of war—was held in St. Just. The scene of the council was the shop of Maggot the blacksmith, and the members of it were a number of miners, the president being the worthy smith himself, who, with a sledge-hammer under his arm in the position of a short crutch, occupied the chair, if we may be allowed so to designate the raised hearth of the forge.

The war with poverty had not been very successfully waged of late, and, at the time of which we write, the enemy had apparently given the miners a severe check, in the way of putting what appeared to be an insuperable obstacle in their path.

"Now, lads," said Maggot, with a slap on the leathern apron that covered his knees, "this is the way on it, an' do 'ee be quiet and hould yer tongues while I do spaik."

The other men, of whom there were nearly a dozen, nodded and said, "Go on, booy; thee's knaw tin, sure;" by which expression they affirmed their belief that the blacksmith was a very knowing fellow.

"You do tell me that you've come so close to water that you're 'fraid to go on? Is that so?"

"Iss, iss," responded the others.

"Well, I'll hole into the house ef you do agree to give un a good pitch," said Maggot.

"Agreed, one and all," cried the miners.

In order that the reader may understand the drift of this conversation, it is necessary to explain that the indefatigable miner, David Trevarrow, whom we have already introduced in his submarine workshop, had, according to his plan, changed his ground, and transferred his labour to a more hopeful part of the mine.

For some time previous the men had been at work on a lode which was very promising, but they were compelled to cease following it, because it approached the workings of an old part of the mine which was known to be full of water. To tap this old part, or as the miners expressed it, to "hole into this house of water," was, they were well aware, an exceedingly dangerous operation. The part of the mine to which we allude was not under the sea, but back a little from the shore, and was not very deep at that time. The adit—or water-conducting—level by which the spot was reached commenced at the cliffs, on a level with the sea-shore, and ran into the interior until it reached the old mine, about quarter of a mile inland. Here was situated the "house," which was neither more nor less than a number of old shafts and levels filled with water. As they had approached the old mine its near proximity was made disagreeably evident by the quantity of moisture that oozed through the crevices in the rocks—moisture which ere long took the form of a number of tiny rills—and at last began to spirt out from roof and sides in such a way that the miners became alarmed, and hesitated to continue to work in a place where they ran the most imminent risk of being suddenly drowned and swept into the sea, by the bursting of the rocks that still withstood the immense pressure of the confined water.

It was at this point in the undertaking that David Trevarrow went to examine the place, and made the discovery of a seam—a "keenly lode"—which had such a promising appearance that the anxiety of the miners to get rid of this obstructive "house" was redoubled.

It was at this point, too, that the council of which we write was held, in order to settle who should have the undesirable privilege of constituting the "forlorn hope" in their subterranean assault.

Maggot, who was known to be one of the boldest, and, at the same time, one of the most utterly reckless men in St. Just, was appealed to in the emergency, and, as we have seen, offered to attack the enemy single-handed, on condition that the miners should give him a "pitch" of the good lode they had found—that is, give him the right to work out a certain number of fathoms of ore for himself.

They agreed to this, but one of them expressed some doubt as to Maggot's courage being equal to the occasion.

To this remark Maggot vouchsafed no other reply than a frown, but his friend and admirer John Cock exclaimed in supreme contempt—

"What! Maggot afear'd to do it! aw, my dear, hould tha tongue."

"But he haven't bin to see the place," urged the previous speaker.

"No, my son," said Maggot, turning on the man with a look of pity, "but he can go an' see it. Come, lads, lev us go an' see this place of danger."

The miners rose at once as Maggot threw his fore-hammer on a heap of coals, put on his hat and strode out of the forge with a reckless fling. A few minutes sufficed to bring them to the beach at the mouth of the adit.

It was a singularly wild spot, close under those precipitous cliffs on which some of the picturesque buildings of Botallack mine are perched—a sort of narrow inlet or gorge which from its form is named the Narrow Zawn. There was nothing worthy of the name of a beach at the place, save a little piece of rugged ground near the adit-mouth, which could be reached only by a zig-zag path on the face of the almost perpendicular precipice.

Arrived here, each man lighted a candle, wrapped the customary piece of wet clay round the middle of it, and entered the narrow tunnel. They advanced in single file, James Penrose leading. The height of the adit permitted of their walking almost upright, but the irregularity of the cuttings rendered it necessary that they should advance carefully, with special regard to their heads. In about quarter of an hour they reached a comparatively open space. That is to say, there were several extensions of the cutting in various directions, which gave the place the appearance of being a small cavern, instead of a narrow tunnel. Here the water, which in other parts of the adit flowed along the bottom, ran down the walls and spirted in fine streams from the almost invisible crevices of the rock, thus betraying at once the proximity and the power of the pent-up water.

"What think'ee now, my son?" asked an elderly man who stood at Maggot's elbow.

After a short pause, during which he sternly regarded the rocks before him, the smith replied, "*I'll do it,*" in the tone and with the air of a man who knows that what he has made up his mind to do is not child's play.

The question being thus settled, the miners retraced their steps and went to their several homes.

Entering his cottage, the smith found his little girl Grace busily engaged in the interesting process of nursing the baby. He seated himself in a chair by the fireside, smoked his pipe, and watched the process, while his wife busied herself in preparing the evening meal.

Oh! but the little Maggot was a big baby—a worthy representative of his father—a true chip of the old block, for he was not only fat, riotous, and muscular, but very reckless, and extremely positive. His little nurse, on the contrary, was gentle and delicate; not much bigger than the baby, although a good deal older, and she had a dreadful business of it to keep him in order. All her efforts at lifting and restraining were somewhat akin to the exertion made by wrestlers to throw each other by main force, and her intense desire to make baby Maggot "be good" was repaid by severe kicks on the shins, and sundry dabs in the face with, luckily, a soft fat pair of fists.

"Sit 'ee quiet, now, or I'll scat oo nose," said the little nurse suddenly, with a terrible frown.

It need scarcely be said that she had not the remotest intention of carrying out this dreadful threat to smash the little Maggot's nose. She accompanied it, however, with a twist that suddenly placed the urchin in a sitting posture, much to his own surprise, for he opened his eyes very wide, drew his breath sharply, and appeared to meditate a roar. He thought better of it, however, and relapsed into goodness just as the door opened, and David Trevarrow entered.

"Oh, uncle David," cried little Grace, jumping up and running towards him, "do help me nuss baby."

"What's the matter with the cheeld—bad, eh? Fetch un to me and I'll cure him."

There was no necessity to fetch baby, for that obstreperous individual entertained an immense regard for "unkil Day," and was already on his fat legs staggering across the floor to him with outstretched arms. Thereafter he only required a pair of wings to make him a complete cherub.

Little Grace, relieved of her charge, at once set to work to assist her mother in household matters. She was one of those dear little earnest creatures who of their own accord act in a motherly and wifely way from their early years. To look at little Grace's serious thoroughgoing face, when she chanced to pause in the midst of work, and meditate what was to be done next, one might imagine that the entire care of the household had suddenly devolved upon her shoulders. In the matter of housewifery little Grace was almost equal to big Grace, her respected mother; in downright honesty and truthfulness she greatly excelled her.

The description of Maggot's household, on that evening, would be very incomplete were we to omit mention of Zackey Maggot. That young man—for man he deemed himself, and man he was, in all respects, except the trifling matters of years, size, and whiskers,—that young man entered the room with his uncle, and, without deigning to change his wet red garments, sat him down at his father's feet and caught hold of a small black kitten, which, at the time, lay sound asleep on the hearth, and began to play with it in a grave patronizing way, as though his taking notice of it at all were a condescension.

That black kitten, or Chet, as it was usually styled, was accustomed to be strangled the greater part of the morning by the baby. Most of the afternoon it was worried by Zackey, and, during the intervals of torment, it experienced an unusually large measure of the vicissitudes incident to kitten life—such as being kicked out of the way by Maggot senior, or thrown or terrified out of the way by Mrs. Maggot, or dashed at by stray dogs, or yelled at by passing boys. The only sunshine of its life (which was at all times liable to be suddenly clouded) was when it slept, or when little Grace put it on her soft neck, tickled its chin, and otherwise soothed its ruffled spirit, as only a loving heart knows how. A bad memory seemed to be that kitten's chief blessing. A horror of any kind was no sooner past than it was straightway forgotten, and the facetious animal would advance with arched back and glaring eyes in defiance of an incursive hen, or twirl in mad hopeless career after its own miserable tail!

"'Tis a keenly lode," said Maggot, puffing his pipe thoughtfully.

"Iss," assented David Trevarrow, also puffing his pipe, at the clouds issuing from which baby gazed with endless amazement and admiration; "it's worth much, but it isn't worth your life."

"Sure, I ain't goin' to give my life for't," replied Maggot.

"But you 're goin' to risk it," said David, "an' you shouldn't, for you 've a wife an' child'n to provide for. Now, I tell 'ee what it is: you lev it to me. *I'll* hole to the house. It don't matter much what happens to me."

"No, 'ee won't," said Maggot stoutly; "what I do promise to do I *will* do."

"But if you die?" said David.

"Well, what if I do? we have all to come to that some day, sooner or later."

"Are you prepared to die?" asked Trevarrow earnestly.

"Now, David, don't 'ee trouble me with that. 'Tis all very well for the women an' child'n, but it don't suit me, it don't, so lev us have no more of it booy. I'll do it to-morrow, that's fixed, so now we'll have a bit supper."

The tone in which Maggot said this assured David that farther conversation would be useless, so he dropped the subject and sat down with the rest of the family to their evening meal.

CHAPTER X.

SHOWS HOW MAGGOT MADE A DESPERATE VENTURE, AND WHAT FLOWED FROM IT.

"A WILFUL man must have his way" is a proverb the truth of which was illustrated by the blacksmith on the following day.

David Trevarrow again attempted to dissuade him from his purpose, and reiterated his offer to go in his stead, but he failed to move him. Mrs. Maggot essayed, and added tears to her suasion, as also did little Grace; but they failed too—the obdurate man would not give way. The only one of his household who did not attempt to dissuade him (excepting, of course, the baby, who cared nothing whatever about the matter) was Zackey. That urchin not only rejoiced in the failure of the others to turn his father from his purpose, but pleaded hard to be allowed to go with him, and share his danger as well as glory. This, however, was peremptorily denied to the young aspirant to fame and a premature death by drowning in a dark hole.

Early in the forenoon Maggot and his friends proceeded to the shore, where they found a number of miners and others assembled near the adit mouth,—among them our hero Oliver Trembath, Mr. Donnithorne, and Mr. Cornish, at that time the purser and manager of Botallack mine.

The latter gentleman accosted Maggot as he came forward, and advised him to be cautious. Of course the smith gave every assurance that was required of him, and immediately prepared himself to make the dangerous experiment.

Supplying himself with a number of tallow-candles, a mining hammer, and other tools, Maggot stripped to the waist, and jestingly bidding his friends farewell, entered the mouth of the tunnel, and disappeared. The adit level, or tunnel, through which he had to pass to the scene of his operations, was, as we have said, about a quarter of a mile in length, about six feet high, and two and a half feet wide. It varied in dimensions here and there, however, and was rough and irregular throughout.

For the first hundred yards or so Maggot could see well enough to grope his way by the daylight which streamed in at the entrance of the adit, but beyond this point all was intense darkness; so here he stopped, and, striking a light by means of flint, steel, and tinder, lit one of his candles. This he attached to a piece of wet clay in the usual fashion, except that he placed the clay at the lower end of the candle instead of round the middle of it. He then stuck it against the rock a little above the level of his head. Lighting another candle he advanced with it in his hand. Walking, or rather wading onward (for the stream was ankle-deep), far enough to be almost beyond the influence of the first candle, he stopped again and stuck up another. Thus, at intervals, he placed candles along the entire length of the adit, so that he might have light to guide him in his race from the water which he hoped to set free. This precaution was necessary, because, although he meant to carry a candle in his hat all the time, there was a possibility—nay, a strong probability—that it would be blown or drowned out.

Little more than a quarter of an hour brought him to the scene of his intended adventure. Here he found the water spirting out all round, much more violently than it had been the day before. He did not waste much time in consideration, having made up his mind on the previous visit as to which part of the rock he would drive the hole through. Sticking his last candle, therefore, against the driest part of the wall that could be found, he seized his tools and commenced work.

We have already said that Maggot was a strong man. As he stood there, naked to the waist, holding the borer with his left hand, and plying the hammer with all his might with the other, his great breadth of shoulder and development of muscle were finely displayed by the candle-light, which fell in brilliant gleams on parts of his frame, while the rest of him was thrown into shadow, so deep that it would have appeared black, but for the deeper shade by which it was surrounded—the whole scene presenting a grand Rembrandt effect.

It is unnecessary to say that Maggot wrought with might and main. Excited somewhat by the novelty and danger of his undertaking, he felt relieved by the violence of his exertion. He knew, besides, that the candles which were to light him on his return were slowly but surely burning down. Blow after blow resounded through the place incessantly. When the smith's right arm felt a very little wearied—it was too powerful to be soon or greatly exhausted—he shifted the hammer to his left hand, and so the work went on. Suddenly and unexpectedly the borer was driven to its head into the hole by a tremendous blow. The rock behind it had given way. Almost at the same instant a large mass of rock burst outwards, followed by a stream of water so thick and violent that it went straight at the opposite side of the cavern, against which it burst in white foam. This, rebounding back and around, rushed against roof and sides with such force that the whole place was at once deluged.

Maggot was knocked down at the first gush, but leaped up and turned to fly. Of course both candles—that in his hat as well as that which he had affixed to the wall—were extinguished, and he was at once plunged in total darkness, for the rays of the next light, although visible, were too feeble to penetrate with any effect to the extremity of the adit. Blinded by rushing water and confused by his fall, the smith mistook his direction, and ran against the side of the level with such violence that he fell again, but his sturdy frame withstood the shock, and once more he sprang to his feet and leaped along the narrow tunnel with all the energy of desperation.

Well was it for Maggot at that hour that his heart was bold and his faculties cool and collected, else then and there his career had ended. Bending forward and stooping low, he bounded away like a hunted deer, but the rush of water was so great that it rapidly gained on him, and, by concealing the uneven places in the path, caused him to stumble. His relay of candles served him in good stead; nevertheless, despite their light and his own caution, he more than once narrowly missed dashing out his brains on the low roof. On came the water after the fugitive, a mighty, hissing, vaulting torrent, filling the level behind, and leaping up on the man higher and higher as he struggled and floundered on for life. Quickly, and before quarter of the distance to the adit mouth was traversed, it gurgled up to his waist, swept him off his legs, and hurled him against projecting rocks. Once and again did he succeed in regaining his foothold, but in a moment or two the rising flood swept him down and hurled him violently onward, sporting with him on its foaming crest until it disgorged him at last, and cast him, stunned, bruised, and bleeding, on the sea-shore.

Of course the unfortunate man's friends had waited for him with some impatience, and great was their anxiety when the first of the flood made its appearance. When, immediately after, the battered form of their comrade was flung on the beach, they ran forward and bore him out of the stream.

Oliver Trembath being on the spot, Maggot was at once attended to, and his wounds bound up.

"He'll do, he's all right," said Oliver, on completing the work; "only got a few cuts and bruises, and lost a little blood, but that won't harm him."

The expression of anxiety that had appeared on the faces of those who stood around at once vanished on hearing these reassuring words.

"I knaw'd it," said John Cock energetically. "I knaw'd he couldn't be killed—not he."

"I trust that you may be right, Oliver," said old Mr. Donnithorne, looking with much concern on the pale countenance of the poor smith, who still lay stretched out, with only a slight motion of the chest to prove that the vital spark had not been altogether extinguished.

"No fear of him, he's sure to come round," replied Oliver; "come lads, up with him on your backs."

He raised the smith's shoulder as he spoke. Three tall and powerful miners promptly lent their aid, and Maggot was raised shoulder-high, and conveyed up the steep winding path that led to the top of the cliffs.

"It would never do to lose Maggot," murmured Mr. Donnithorne, as if speaking to himself while he followed the procession beside Mr. Cornish; "he's far too good a—"

"A smuggler—eh?" interrupted the purser, with a laugh.

"Eh, ah! did I say smuggler?" cried Mr. Donnithorne; "surely not, for of all vices, that of smuggling is one of the worst, unless it be an overfondness for the bottle. I meant to have said that he is too valuable a man for St. Just to lose—in many ways; and you know, Mr. Cornish, that he is a famous wrestler,—a man of whom St. Just may be justly proud."

Mr. Donnithorne cast a sly glance at his companion, whom he knew to be partial to the ancient Cornish pastime of wrestling. Indeed, if report said truly, the worthy purser had himself in his youthful days been a celebrated amateur wrestler, one who had never been thrown, even although he had on more than one occasion been induced in a frolic to enter the public ring and measure his strength with the best men that could be brought against him. He was long past the time of life when men indulge in such rough play, but his tall commanding figure and huge chest and shoulders were quite sufficient to warrant the belief that what was said of him was possible, while the expression of his fine massive countenance, and the humorous glance of his clear, black eye, bore evidence that it was highly probable.

"'Twould be foul injustice," said the purser with a quiet laugh, "if I were to deny that Maggot is a good man and true, in the matter of wrestling; nevertheless he is an arrant rogue, and defrauds the revenue wofully. But, after all, he is only the cat's-paw; those who employ him are the real sinners—eh, Mr. Donnithorne?"

"Surely, surely," replied the old gentleman with much gravity; "and it is to be hoped that this accident will have the effect of turning Maggot from his evil ways."

The purser could not refrain from a laugh at the hypocritical solemnity of the old gentleman, who was, he well knew, one of the very sinners whom he condemned with such righteous indignation, but their arrival at Maggot's cottage prevented farther conversation on the subject at that time.

Mrs. Maggot, although a good deal agitated when her husband's almost inanimate and bloody form was carried in and laid on the bed, was by no means overcome with alarm. She, like the wives of St. Just miners generally, was too well accustomed to hear of accidents and to see their results, to give way to wild fears before she had learned the extent of her calamity; so, when she found that it was not serious, she dried her eyes, and busied herself in attending to all the little duties which the occasion required. Little Grace, too, although terribly frightened, and very pale, was quite self-possessed, and went about the house assisting her mother ably, despite the tendency to sob, which she found it very difficult to overcome. But the baby behaved in the most shameful and outrageous manner. His naughtiness is almost indescribable. The instant the door opened, and his father's bloody face was presented to view, baby set up a roar so tremendous that a number of dogs in the neighbourhood struck in with a loud chorus, and the black kitten, startled out of an innocent slumber, rushed incontinently under the bed, faced about, and fuffed in impotent dismay!

But not only did baby roar—he also fell on the floor and kicked, thereby rendering his noise exasperating, besides exposing his fat person to the risk of being trod upon. Zackey was therefore told off as a detachment to keep this enemy in check, a duty which he performed nobly, until his worthy father was comfortably put to bed, after which the friends retired, and left the smith to the tender care of his own family.

"He has done good service anyhow," observed Mr. Donnithorne to his nephew, as he parted from him that evening; "for he has cleared the mine of water that it would have cost hundreds of pounds and many months to pump out."

CHAPTER XI.

SHOWS THAT MUSIC HATH CHARMS, AND ALSO THAT IT SOMETIMES HAS DISADVANTAGES.

One morning, not long after his arrival at St. Just, the young doctor went out to make a round of professional visits. He had on his way to pass the cottage of his uncle, which stood a little apart from the chief square or triangle of the town, and had a small piece of ground in front. Here Rose was wont to cultivate her namesakes, and other flowers, with her own fair hands, and here Mr. Thomas Donnithorne refreshed himself each evening with a pipe of tobacco, the flavour of which was inexpressibly enhanced to him by the knowledge that it had been smuggled. He was in the habit of washing the taste of the same away each night, before retiring to rest, with a glass of brandy and water, hot, which was likewise improved in flavour by the same interesting association.

The windows of the cottage were wide open, for no Atlantic fog dimmed the glory of the summer sun that morning, and the light air that came up from the mighty sea was fresh and agreeably cool.

As Oliver approached the end of the cottage, he observed that Rose was not at her accustomed work in the garden, and he was about to pass the door when the tones of a guitar struck his ear and arrested his step He was surprised, for at that period the instrument was not much used, and the out-of-the way town of St. Just was naturally the last place in the land where he would have expected to meet with one. No air was played—only a few chords were lightly touched by fingers, which were evidently expert. Presently a female voice was heard to sing in rich contralto tones. The air was extremely simple, and very beautiful—at least so thought Oliver, as he leaned against a wall and listened to the words. These, also, were simple enough, but sounded both sweet and sensible to the listener, coming as they did from a woman's lips so tunefully, and sounding, as they did, the praises of the sea, of which he was passionately fond:—

SONG.

"I love the land where acres broad
Are clothed in yellow grain;
Where cot of thrall and lordly hall
Lie scattered o'er the plain.
Oh! I have trod the velvet sod
Beneath the beechwood tree;
And roamed the brake by stream and lake
Where peace and plenty be.
But more than plain,
Or rich domain,
I love the bright blue sea!

"I love the land where bracken grows
And heath-clad mountains rise;
Where peaks still fringed with winter snows
Tower in the summer skies.
Oh! I have seen the red and green
Of fir and rowan tree,
And heard the din of flooded linn,
With bleating on the lea.
But better still
Than heath-clad hill
I love the stormy sea!"

The air ceased, and Oliver, stepping in at the open door, found Rose Ellis with a Spanish guitar resting on her knee. She neither blushed nor started up nor looked confused—which was of course very strange of her in the circumstances, seeing that she is the heroine of this tale,—but, rising with a smile on her pretty mouth, shook hands with the youth.

"Why, cousin," said Oliver, "I had no idea you could sing so charmingly."

"I am fond of singing," said Rose.

"So am I, especially when I hear such singing as yours; and the song, too,—I like it much, for it praises the sea. Where did you pick it up?"

"I got it from the composer, a young midshipman," said Rose sadly; at the same time a slight blush tinged her brow.

Oliver felt a peculiar sensation which he could not account for, and was about to make farther inquiries into the authorship of the song, when it occurred to him that this would be impolite, and might be awkward, so he asked instead how she had become possessed of so fine a guitar. Before she could reply Mr. Donnithorne entered.

"How d' 'ee do, Oliver lad; going your rounds—eh? Come, Rose, let's have breakfast, lass, you were not wont to be behind with it. I'll be bound this gay gallant—this hedge-jumper with his eyes shut—has been praising your voice and puffing up your heart, but don't believe him, Rose; it's the fashion of these fellows to tell lies on such matters."

"You do me injustice, uncle," said Oliver, with a laugh; "but even if it were true that I am addicted to falsehood in praising women, it were impossible, in the present instance, to give way to my propensity, for Truth herself would find it difficult to select an expression sufficiently appropriate to apply to the beautiful voice of Rose Ellis!"

"Hey-day, young man," exclaimed Mr. Donnithorne, as he carefully filled his pipe with precious weed, "your oratorical powers are uncommon! Surely thy talents had been better bestowed in the Church or at the Bar than in the sick-room or the hospital. Demosthenes himself would have paled before thee, lad—though, if truth must be told, there is a dash more of sound than sense in thine eloquence."

"Sense, uncle! Surely your own good sense must compel you to admit that Rose sings splendidly?"

"Well, I won't gainsay it," replied Mr. Donnithorne, "now that Rose has left the room, for I don't much care to bespatter folk with too much praise to their faces. The child has indeed a sweet pipe of her own. By the way, you were asking about her guitar when I came in, I'll tell you about that.

"Its history is somewhat curious," said Mr. Donnithorne, passing his fingers through the bunch of gay ribbons that hung from the head of the instrument. "You have heard, I daresay, of the burning of Penzance by the Spaniards more than two hundred years ago; in the year 1595, I think it was?"

"I have," answered Oliver, but I know nothing beyond the fact that such an event took place. I should like to hear the details of it exceedingly."

"Well," continued the old gentleman, "our country was, as you know, at war with Spain at the time; but it no more entered into the heads of Cornishmen that the Spaniards would dare to land on our shores, than that the giants would rise from their graves. There was, indeed, an old prediction that such an event would happen, but the prediction was either forgotten or not believed, so that when several Spanish galleys suddenly made their appearance in Mounts Bay, and landed about two hundred men near Mousehole, the inhabitants were taken by surprise. Before they could arm and defend themselves, the Spaniards effected a landing, began to devastate the country, and set fire to the adjacent houses.

"It is false," continued the old man sternly, "to say, as has been said by some, that the men of Mousehole were seized with panic, and that those of Newlyn and Penzance deserted their houses terror-stricken. The truth is, that the suddenness of the attack, and their unprepared condition to repel it, threw the people into temporary confusion, and forced them to retreat, as, all history shows us, the best and bravest will do at times. In Mousehole, the principal inhabitant was killed by a cannon-ball, so that, deprived of their leading spirit at the critical moment when a leader was necessary, it is no wonder that *at first* the fishermen were driven back by well-armed men trained to act in concert. To fire the houses was the work of a few minutes. The Spaniards then rushed on to Newlyn and Penzance, and fired these places also, after which they returned to their ships, intending to land the next day and renew their work of destruction.

"But that night was well spent by the enraged townsmen. They organized themselves as well as they could in the circumstances, and, when day came, attacked the Spaniards with guns and bows, and that so effectively, that the Dons were glad to hoist their sails and run out of the bay.

"Well, you must know there was one of the Spaniards, who, it has been said, either from bravado, or vanity, or a desire to insult the English, or from all three motives together, brought a guitar on shore with him at Mousehole, and sang and played to his comrades while they were burning the houses. This man left his guitar with those who were left to guard the boats, and accompanied the others to Penzance. On his return he again took his guitar, and, going up to a high point of the cliff, so that he might be seen by his companions and heard by any of the English who chanced to be in hiding near the place, sang several songs of defiance at the top of his voice, and even went the length of performing a Spanish dance, to the great amusement of his comrades below, who were embarking in their boats.

"While the half-crazed Spaniard was going on thus he little knew that, not three yards distant from him, a gigantic Mousehole fisherman, who went by the name of Gurnet, lay concealed among some low bushes, watching his proceedings with an expression of anger on his big stern countenance. When the boats were nearly ready to start the Spaniard descended from the rocky ledge on which he had been performing, intending to rejoin his comrades. He had to pass round the bush where

Gurnet lay concealed, and in doing so was for a few seconds hid from his comrades, who immediately forgot him in the bustle of departure, or, if they thought of him at all, each boat's crew imagined, no doubt, that he was with one of the others.

"But he never reached the boats. As he passed the bush Gurnet sprang on him like a tiger and seized him round the throat with both hands, choking a shout that was coming up, and causing his eyes to start almost out of his head. Without uttering a word, and only giving now and then a terrible hiss through his clenched teeth, Gurnet pushed the Spaniard before him, keeping carefully out of sight of the beach, and holding him fast by the nape of the neck, so that when he perceived the slightest symptom of a tendency to cry out he had only to press his strong fingers and effectually nip it in the bud.

"He led him to a secluded place among the rocks, far beyond ear-shot of the shore, and there, setting him free, pointed to a flat rock and to his guitar, and hissed, rather than said, in tones that could neither be misunderstood nor gainsaid—

"'There, dance and sing, will 'ee, till 'ee bu'st!'"

Gurnet clenched his huge fist as he spoke, and, as the Spaniard grew pale, and hesitated, he shook it close to his face,—so close that he tapped the prominent bridge of the man's nose, and hissed again, more fiercely than before—

"'Ye haaf saved bucca, ye mazed totle, that can only frighten women an' child'n, an' burn housen; thee 'rt fond o' singin' an' dancin'—dance now, will 'ee, ye gurt bufflehead, or ef ye waant I'll scat thee head in jowds, an' send 'ee scrougin' over cliffs, I will.'*

"The fisherman's look and action were so terrible whilst he poured forth his wrath, which was kept alive by the thought of the smouldering embers of his own cottage, that the Spaniard could not but obey. With a ludicrous compound of fun and terror he began to dance and sing, or rather to leap and wail, while Gurnet stood before him with a look of grim ferocity that never for a moment relaxed.

"Whenever the Spaniard stopped from exhaustion Gurnet shouted 'Go on,' in a voice of thunder, and the poor man, being thoroughly terrified, went on until he fell to the ground incapable of farther exertion.

"Up to this point Gurnet had kept saying to himself, 'He is fond o' dancin' an' singin', let un have it, then,' but when the poor man fell his heart relented. He picked him up, threw him across his shoulder as if he had been a bolster, and bore him away. At first the men of the place wanted to hang him on the spot, but Gurnet claimed him as his prisoner, and would not allow this. He gave him his liberty, and the poor wretch maintained himself for many a day as a wandering minstrel. At last he managed to get on board of a Spanish vessel, and was never more heard of, but he left his guitar behind him. It was picked up on the shore, where he left it, probably, in his haste to get away.

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* In justice to the narrator it is right to say that these words are not so bad as they sound!

"The truth of this story, of course, I cannot vouch for," concluded Mr. Donnithorne, with a smile, "but I have told it to you as nearly as possible in the words in which I have often heard my grandfather give it—and as for the guitar, why, here it is, having been sold to me by a descendant of the man who found it on the sea-shore."

"A wonderful story indeed," said Oliver,—"*if true.*"

"The guitar you must admit is at least a fact," said the old gentleman.

Oliver not only admitted this, but said it was a sweet-sounding fact, and was proceeding to comment farther on the subject when Mr. Donnithorne interrupted him,—

"By the way, talking of sweet sounds, have you heard what that gruff-voiced scoundrel Maggot—that roaring bull of Bashan—has been about lately?"

"No, I have not," said Oliver, who saw that the old gentleman's ire was rising.

"Ha! lad, that man ought to be hanged. He is an arrant knave, a smuggler—a—an ungrateful rascal.

Why, sir, you'll scarcely believe it: he has come to me and demanded more money for the jewels which he and his comrade sold me in fair and open bargain, and because I refused, and called him a few well-merited names, he has actually gone and given information against me as possessor of treasure, which of right, so they say, belongs to Government, and last night I had a letter which tells me that the treasure, as they call it, must be delivered up without delay, on pain of I don't know what penalties. Penalties, forsooth! as if I hadn't been punished enough already by the harassing curtain-lectures of my over-scrupulous wife, ever since the unlucky day when the baubles were found, not to mention the uneasy probings of my own conscience, which, to say truth, I had feared was dead altogether owing to the villanous moral atmosphere of this smuggling place, but which I find quite lively and strong yet—a matter of some consolation too, for although I do have a weakness for cheap 'baccy and brandy, being of an economical turn of mind, I don't like the notion of getting rid of my conscience altogether. But, man, 'tis hard to bear!"

Poor Mr. Donnithorne stopped here, partly owing to shortness of breath, and partly because he had excited himself to a pitch that rendered coherent speech difficult.

"Would it not be well at once to relieve your conscience, sir," suggested Oliver respectfully, "by giving up the things that cause it pain? In my profession we always try to get at the root of a disease, and apply our remedies there."

"Ha!" exclaimed the old gentleman, wiping his heated brow, "and lose twenty pounds as a sort of fee to Doctor Maggot, who, like other doctors I wot of, created the disease himself, and who will certainly never attempt to alleviate it by returning the fee."

"Still, the disease may be cured by the remedy I recommend," said Oliver.

"No, man, it can't," cried the old gentleman with a perplexed expression, "because the dirty things are already sold and the money is invested in Botallack shares, to sell which and pay back the cash in the present depressed state of things would be utter madness. But hush! here comes my better-half, and although she *is* a dear good soul, with an unusual amount of wisdom for her size, it would be injudicious to prolong the lectures of the night into the early hours of morning."

As he spoke little Mrs. Donnithorne's round good-looking face appeared like the rising sun in the doorway, and her cheery voice welcomed Oliver to breakfast.

"Thank you, aunt," said Oliver, "but I have already breakfasted more than an hour ago, and am on my way to visit my patients. Indeed, I have to blame myself for calling at so early an hour, and would not have done so, but for the irresistible attraction of a newly discovered voice, which—"

"Come, come, youngster," interrupted Mr. Donnithorne, "be pleased to bear in remembrance that the voice is connected with a pair of capital ears, remarkable for their sharpness, if not their length, and at no great distance off, I warrant."

"You do Rose injustice," observed Mrs. Donnithorne, as the voice at that moment broke out into a lively carol in the region of the kitchen, whither its owner had gone to superintend culinary matters. "But tell me, Oliver, have you heard of the accident to poor Batten?"

"Yes, I saw him yesterday," replied the doctor, "just after the accident happened, and I am anxious about him. I fear, though I am not quite certain, that his eyesight is destroyed."

"Dear! dear!—oh, poor man," said Mrs. Donnithorne, whose sympathetic heart swelled, while her blue eyes instantly filled with tears. "It is so very sad, Oliver, for his delicate wife and four young children are entirely dependent upon him and his two sons—and they found it difficult enough to make the two ends meet, even when they were all in health; for it is hard times among the miners at present as you know, Oliver; and now,—dear, dear, it is very, *very* sad."

Little Mrs. Donnithorne said nothing more at that time, but her mind instantly reverted to a portly basket which she was much in the habit of carrying with her on her frequent visits to the poor and the sick—for the good lady was one of those whose inclinations as well as principles lead them to "consider the poor."

It must not be imagined, however, that the poor formed a large class of the community in St. Just. The miners of that district, and indeed all over Cornwall, were, and still are, a self-reliant, independent, hard-working race, and as long as tough thews and sinews, and stout and willing hearts, could accomplish anything, they never failed to wrench a subsistence out of the stubborn rocks which contain the wealth of the land. Begging goes very much against the grain of a Cornishman, and the lowest depth to which he can sink socially, in his own esteem, is that of being dependent on charity.

In some cases this sentiment is carried too far, and has degenerated into pride,—for, when God in His wisdom sees fit, by means of disabling accident or declining health, to incapacitate a man from labour, it is as honourable in him to receive charity as it is (although not always sufficiently esteemed so) a high privilege and luxury of the more fortunate to give.

Worthy Mrs. Donnithorne's charities were always bestowed with such delicacy that she managed, in some mysterious way, to make the recipients feel as though they had done her a favour in accepting them. And yet she was not a soft piece of indiscriminating amiability, whose chief delight in giving lay in the sensations which the act created within her own breast. By no means. None knew better than she when and where to give money, and when to give blankets, bread, or tea. She was equally sharp to perceive the spirit that rendered it advisable for her to say, " I want you to do me a favour—there 's a good woman now, you won't refuse me, etc.," and to detect the spirit that called forth the sharp remark, accompanied with a dubious smile and a shake of her fat forefinger—" There now, see that you make better use of it *this* time, else I shall have to scold you."

Having received a message for poor Mrs. Batten, the miner's wife, the doctor left the cottage, and proceeded to pay his visits. Let us accompany him.

CHAPTER XII.

IN WHICH OLIVER GETS "A FALL," AND SEES SOME OF THE SHADOWS OF THE MINER'S LIFE.

In crossing a hayfield, Oliver Trembath encountered the tall, bluff figure, and the grave, sedate smile of Mr. Cornish, the manager.

"Good morning, doctor," said the old gentleman, extending his hand and giving the youth a grasp worthy of one of the old Cornish giants; "do you know I was thinking, as I saw you leap over the stile, that you would make a pretty fair miner?"

"Thanks, sir, for your good opinion of me," said Oliver, with a smile, "but I would rather work above than below ground. Living the half of one's life beyond the reach of sunlight is not conducive to health."

"Nevertheless, the miners keep their health pretty well, considering the nature of their work," replied Mr. Cornish; "and you must admit that many of them are stout fellows. You would find them so if you got one of their Cornish hugs."

"Perhaps," said Oliver, with a modest look, for he had been a noted wrestler at school, "I might give them a pretty fair hug in return, for Cornish blood flows in my veins."

"A fig for blood, doctor; it is of no avail without knowledge and practice, as well as muscle. *With* these, however, I do acknowledge that it makes weight—if by 'blood' you mean high spirit."

"By the way, how comes it, sir," said Oliver, "that Cornishmen are so much more addicted to wrestling than other Englishmen?"

"It were hard to tell, doctor, unless it be that they feel themselves stronger than other Englishmen, and being accustomed to violent exertion more than others, they take greater pleasure in it. Undoubtedly the Greeks introduced it among us, but whether they practised it as we now do cannot be certainly ascertained."

Here Mr. Cornish entered into an enthusiastic account of the art of wrestling; related many anecdotes of his own prowess in days gone by, and explained the peculiar method of performing the throw by the heel, the toe, and the hip; the heave forward, the back-heave, and the Cornish hug, to all of which the youth listened with deep interest.

"I should like much to witness one of your wrestling-matches," he said, when the old gentleman concluded, "for I cannot imagine that any of your peculiar Cornish hugs or twists can be so potent as to overturn a stout fellow who is accustomed to wrestle in another fashion. Can you show me one of the particular grips or twists that are said to be so effective?"

"I think I can," replied the old gentleman, with a smile, and a twinkle in his eye; "of course the style of grip and throw will vary according to the size of the man one has to deal with. Give me hold of your wrist, and plant yourself firmly on your legs. Now, you see, you must turn the arm—so, and use your toe—thus, so as to lift your man, and, with a sudden twist—*there.* That's the way to do it!" said the old gentleman, with a chuckle, as he threw Oliver head-foremost into the middle of a haycock that lay opportunely near.

It is hard to say whether Mr. Cornish or Oliver was most surprised at the result of the effort—the one, that so much of his ancient prowess should remain, and the other, that he should have been so easily overthrown by one who, although fully as large a man as himself, had his joints and muscles stiffened somewhat by age.

Oliver burst into a fit of laughter on rising, and exclaimed, "Well done, sir! You have effectually convinced me that there is something worth knowing in the Cornish mode of wrestling, although, had I known what you were about to do, it might not perhaps have been done so easily."

"I doubt it not," said Mr. Cornish, with a laugh, "but that shows the value of 'science' in such matters. Good morning, doctor. Hope you'll find your patients getting on well."

He waved his hand as he turned off, while Oliver pursued his way to the miners' cottages.

The first he entered belonged to a man whose chest was slightly affected for the first time. He was a stout man, about thirty-five years of age, and of temperate habits—took a little beer occasionally, but never exceeded; had a good appetite, but had caught cold frequently in consequence of having to go a considerable distance from the shaft's mouth to the changing house while exhausted with hard work underground and covered with profuse perspiration. Often he had to do this in wet weather and when bitterly cold winds were blowing,—of late he had begun to spit blood.

It is necessary here to remind the reader that matters in this respect—and in reference to the condition of the miner generally—are now much improved. The changing-houses, besides being placed as near to the several shafts as is convenient, are now warmed with fire, and supplied with water-troughs, so that the men have a comfortable place in which to wash themselves on coming "to grass." and find their clothes thoroughly dried when they return in the morning to put them on, before going underground. This renders them less likely to catc cold, but of course does not protect them from the evil influences of climbing the ladders, and of bad air. Few men have to undergo such severe toil as the Cornish miner, because of the extreme hardness of the rock with which he has to deal. To be bathed in perspiration, and engaged in almost unremitting and violent muscular exertion during at least eight hours of each day, may be said to be his normal condition.

Oliver advised this man to give up underground work for some time, and, having prescribed for him and spoken encouragingly to his wife, left the cottage to continue his rounds.

Several cases, more or less similar to the above, followed each other in succession; also one or two cases of slight illness among the children, which caused more alarm to the anxious mothers than there was any occasion for. These latter were quickly but good-naturedly disposed of, and the young doctor generally left a good impression behind him, for he had a hearty, though prompt manner, and a sympathetic spirit.

At one cottage he found a young man in the last stage of consumption. He lay on his lowly bed pale and restless—almost wishing for death to relieve him of his pains. His young wife sat by his bedside wiping the perspiration from his brow, while a ruddy-cheeked little boy romped about the room unnoticed,—ignorant that the hour was drawing near which would render him fatherless, and his young mother a widow.

This young man had been a daring high-spirited fellow, whose animal spirits led him into many a reckless deed. His complaint had been brought on by racing up the ladders—a blood-vessel had given way, and he never rallied after. Just as Oliver was leaving him a Wesleyan minister entered the dwelling.

"He won't be long with us, doctor, I fear," he said in passing.

"Not long, sir," replied Oliver.

"His release will be a happy one," said the minister, "for his soul rests on Jesus; but, alas! for his young wife and child."

He passed into the sick-room, and the doctor went on.

The next case was also a bad one, though different from the preceding. The patient was between forty and fifty years of age, and had been unable to go underground for several years. He was a staid, sober man, and an abstemious liver, but it was evident that his life on earth was drawing to a close. He had been employed chiefly in driving levels, and had worked a great deal in very bad air, where the candles could not be made to burn unless placed nine or ten feet behind the spot where he was at work. Indeed, he often got no fresh air except what was blown to him. and only a puff now and then. When he first went to work in the morning the candle would not keep alight, so that he had to take his coat and beat the air about before going into the level, and, after a time, went in when the candles could be got to burn by holding them on one side, and teasing out the wick very much. This used to create a great deal of smoke, which tended still farther to vitiate the air. When he returned "to grass" his saliva used to be as black as ink. About five years before giving up underground work he had had inflammation of the lungs, followed by blood-spitting, which used to come on when he was at work in what he called "poor air," or in "cold-damp," and he had never been well since.

Oliver's last visit that day was to the man John Batten, who had exploded a blast-hole in his face the day before. This man dwelt in a cottage in the small hamlet of Botallack, close to the mine of the same name. The room in which the miner lay was very small, and its furniture scanty, nevertheless it was clean and neatly arranged. Everything in and about the place bore evidence of the presence of a thrifty hand. The cotton curtain on the window was thin and worn, but it was well darned, and pure as the driven snow. The two chairs were old, as was also the table, but they were not rickety; it was obvious that they owed their stability to a hand skilled in mending and in patching pieces of things together. Even the squat little stool in the side of the chimney-corner displayed a leg, the whiteness of which, compared with the other two, told of attention to small things. There was a peg for everything, and everything seemed to be on its peg. Nothing littered the well-scrubbed floor or defiled the well-brushed hearth-stone, and it did not require a second thought on the part of the beholder to ascribe all this to the tidy little middle-aged woman, who, with an expression of deep anxiety on her good-looking countenance, attended to the wants of her injured husband.

As Oliver approached the door of this cottage two stout youths, of about sixteen and seventeen respectively, opened it and issued forth.

"Good morning, lads! Going to work, I suppose?" said Oliver.

"Iss, sur," replied the elder, a fair-haired ruddy youth, who, like his brother, had not yet sacrificed his colour to the evil influences of the mines; "we do work in the night corps, brother and me. Father is worse to-day, sur."

"Sorry to hear that," said the doctor, as he passed them and entered the cottage, while the lads shouldered their tools and walked smartly down the lane that led to Botallack mine.

"Your husband is not quite so well to-day, I hear," said the doctor, going to the side of the bed on which the stalwart form of the miner lay.

"No, sur," replied the poor woman; "he has much pain in his eyes to-day, but his heart is braave, sur; I never do hear a complaint from he."

This was true. The man lay perfectly still, the compressed lip and the perspiration that moistened his face alone giving evidence of the agony he endured.

"Do you suffer much?" inquired the doctor, as he undid the bandages which covered the upper part of the man's face.

"Iss sur, I do," was the reply.

No more was said, but a low groan escaped the miner when the bandage was removed, and the frightful effects of the accident were exposed to view. With intense anxiety Mrs. Batten watched the doctor's countenance, but found no comfort there. A very brief examination was sufficient to convince Oliver that the eyes were utterly destroyed, for the miner had been so close to the hole when it exploded that the orbs were singed by the flame, and portions of unburnt powder had been blown right into them.

"Will he see—*a little*, sur?" whispered Mrs. Batten.

Oliver shook his head. "I fear not," he said in a low tone.

"Speak out, doctor," said the miner in firm tones, "I ain't afeard to knaw it."

"It would be unkind to deceive you," replied Oliver sadly; "your eyes are destroyed."

No word was spoken for a few minutes, but the poor woman knelt by her husband's side, and nestled close to him. Batten raised his large brown hand, which bore the marks and scars of many a year of manly toil, and laid it gently on his wife's head.

"I'll never see thee again, Annie," he murmured in a low deep tone, "but I see thee face now, lass, as I *last* saw it, wi' the smile of an angel on 't—an' I'll see it so till the day I die; bless the Lord for that."

Mrs. Batten rose and went softly but quickly out of the room that she might relieve her bursting heart without distressing her husband, but he knew her too well to doubt the reason of her sudden movement, and a faint smile was on his lips for a moment as he said to Oliver—

"She's gone to weep a bit, sur, and pray. It will do her good, dear lass."

"Your loss is a heavy one—*very* heavy," said Oliver, with hesitation in his tone, for he felt some difficulty in attempting to comfort one in so hopeless a condition.

"True, sur, true," replied the man in a tone of cheerful resignation that surprised the doctor, "but it might have been worse; 'the Lord gave, and the Lord hath taken away, blessed be the name of the Lord!'"

Mrs. Batten returned in a few minutes, and Oliver left them, after administering as much comfort as he could in the circumstances, but to say truth, although well skilled in alleviating bodily pains, he was incapable of doing much in the way of ministering to the mind diseased. Oliver Trembath was not a medical missionary. His mother, though a good, amiable woman, had been a weak, easy-going creature—one of those good-tempered, listless ladies who may be regarded as human vegetables, who float through life as comfortably as they can, giving as little trouble as possible, and doing as little good as is compatible with the presence of even nominal Christianity. She performed the duties of life in the smallest possible circle, the centre of which was herself, and the extremity of the radii extending to the walls of her garden. She went to church at the regulation hours; "said her prayers" in the regulation tone of voice; gave her charities in the stated way, at stated periods, with a hazy perception as to the objects for which they were given, and an easy indifference as to the success of these objects—the whole end and aim of her wishes being attained in, and her conscience satisfied by, the act of giving. Hence her son Oliver was not much impressed in youth with the power or value of religion, and hence he found himself rather put out when his common sense told him, as it not unfrequently did, that it was his duty sometimes to administer a dose to the mind as well as to the body.

But Oliver was not like his mother in any respect. His fire, his energy, his intellectual activity, and his impulsive generosity, he inherited from his father. Amiability alone descended to him from his mother—an inheritance, by the way, not to be lightly esteemed, for by it all his other qualities were immeasurably enhanced in value. His heart had beat in sympathy with the mourners he had just left, and his manly disposition made him feel ashamed that the lips which could give advice glibly enough in regard to bandages and physic, and which could speak in cheery, comforting tones when there was hope for his patient—were sealed and absolutely incapable of utterance when death approached or hopeless despair took possession of the sufferer.

Oliver had felt something of this even in his student life, when the solemnities of sickness and death were new to him; but it was pressed home upon him with peculiar power, and his manhood was often put to the blush when he was brought into contact with the Wesleyan Methodism of West Cornwall, where multitudes of men and women of all grades drew comfort from the Scriptures as readily and as earnestly as they drew water from their wells, —where religion was mingled with every-day and household duties,—and where many of the miners and fishermen preached and prayed, and comforted one another with God's Word, as vigorously, as simply, and as naturally, as they hewed a livelihood from the rocks or drew sustenance from the sea.

CHAPTER XIII.

TREATS OF SPIRITS AND OF SUNDRY SPIRITED MATTERS AND INCIDENTS.

One sunny afternoon Mrs. Maggot found herself in the happy position of having so thoroughly completed her round of household work, that she felt at leisure to sit down and sew, while little Grace sat beside her, near the open door, rocking the cradle.

Baby, in blissful unconsciousness of its own existence, lay sound asleep with a thumb in its mouth; the resolute sucking of that thumb having been its most recent act of disobedience.

Little Grace was flushed, and rather dishevelled, for it had cost her half an hour's hard wrestling to get baby placed in recumbent somnolence. She now sought to soothe her feelings by tickling the chin of the black kitten—a process to which that active creature submitted with purring satisfaction.

"Faither 's long of coming hum, mother," said little Grace, looking up.

"Iss," replied Mrs. Maggot.

"D' 'ee knaw where he is?" inquired Grace.

"No, I doan't," replied her mother.

It was evident that Mrs. Maggot was not in the humour for conversation, so Grace relapsed into silence, and devoted herself to the kitten.

"Is that faither?" said Grace, after a few minutes, pointing to the figure of a man who was seen coming over the distant moor or waste-land which at that period surrounded the town of St. Just, though the greater part of it is now cultivated fields.

"It isn' like un," said Mrs. Maggot, shading her eyes with her hand; "sure, it do look like a boatsman."*

"Iss, I do see his cutlash," said little Grace; "and there's another man comin' down road to meet un."

"Haste 'ee, Grace," cried Mrs. Maggot, leaping up and plucking her last-born out of the cradle, "take the cheeld in to Mrs. Penrose, an' bide theer till I send for 'ee—dost a hear?"

Plucked thus unceremoniously from gentle slumber to be plunged headlong and without preparation into fierce infantine war, was too much for baby Maggot; he uttered one yell of rage and defiance, which was succeeded by a lull—a sort of pause for the recovery of breath—so prolonged that the obedient Grace had time to fling down the horror-struck "Chet," catch baby in her arms, and bear him into the neighbouring cottage before the next roar came forth. The youthful Maggot was at once received into the bosom of the Penrose family, and succeeding yells were smothered by eight out of the sixteen Penroses who chanced to be at home at the time.

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* The men of the coast-guard were called "boatsmen" at that time.

That Mrs. Maggot had a guilty conscience might have been inferred from her future proceedings, which, to one unacquainted with the habits of her husband, would have appeared strange, if not quite unaccountable. When baby was borne off, as related, she seized a small keg, which stood in a corner near the door and smelt strongly of brandy, and, placing it with great care in the vacant cradle, covered it over with blankets. She next rolled a pair of stockings into a ball and tied on it a little frilled nightcap, which she disposed on the pillow, with the face pretty well down, and the back of the head pretty well up, and so judiciously and cleverly covered it with bed-clothes, that even Maggot himself might have failed to miss his son, or to recognise the outlines of a keg. A bottle half full of brandy, with the cork out, was next placed on the table to account for the odour in the room, and then Mrs. Maggot sat down to her sewing, and rocked the cradle gently with her foot, singing a sweet lullaby the while. Ten minutes later, two stout men of the coast-guard, armed with cutlasses and pistols, entered the cottage. Mrs. Maggot observed that they were also armed with a pick and shovel.

"Good hevenin', missus; how dost do?' said the man who walked foremost, in a hearty voice.

"Good hevenin', Eben Trezise; how are *you?*" said Mrs. Maggot.

"Braave, thank 'ee," said Trezise; "we 've come for a drop o' brandy, missus, havin' heard that you 've got some here, an' sure us can smell it—eh!"

"Why, iss, we 've got wan small drop," said Mrs. Maggot, gently arranging the clothes on the cradle, "that the doctor have order for the chéeld. You 're welcome to a taste of it, but plaise don't make so much noise, for the poor cheeld 's slaipin'.

"He 'll be smothered, I do think, if you don't turn his head up a bit, missus," said the man; "hows'-ever you 've no objection to let Jim and me have a look round the place, I dessay?"

Mrs. Maggot said they were welcome to do as they pleased, if they would only do it quietly for the sake of the "cheeld;" so without more ado they commenced a thorough investigation of the premises, outside and in. Then they went to the smithy, where Mrs. Maggot knew her husband had concealed two large kegs of smuggled liquor on the hearth under a heap of ashes and iron *débris*, but these had been so cleverly, yet carelessly, hidden that the men sat down on the heap under which they lay, to rest and wipe their heated brows after their fruitless search.

"Hast 'ee found the brandy?" inquired Mrs. Maggot, with a look of innocence, when the two men returned.

"Not yet," replied Eben Trezise; "but we 've not done. There 's a certain shaft near by that has got a bad name for drinkin', missus; p'raps you may have heard on it? Its breath do smell dreadful bad sometimes."

Both men laughed at this, and winked to each other, while Mrs. Maggot smiled, and, with a look of surprise, vowed that she had not heard of the disreputable shaft referred to.

Despite her unconcerned look, however, Mrs. Maggot felt anxious, for she was aware that her husband had recently obtained an unusually large quantity of French brandy and tobacco from the Scilly Islands, between which and the coasts of Cornwall smuggling was carried on in a most daring manner in the early part of the present century, and she knew that the whole of the smuggled goods lay concealed in one of those numerous disused shafts of old mines which lie scattered thickly over that part of the country. Maggot's absence rendered her position still more perplexing, but she was a woman of ready wit and self-reliance, and she comforted herself with the knowledge that the brandy lay buried far down in the shaft, and that it would take the boatsmen some time to dig to it—

that possibly they might give up in despair before reaching it.

While the men went off to search for the shaft, and while Mrs. Maggot was calmly nursing her spirited little baby, Maggot himself, in company with his bosom friend John Cock, was sauntering slowly homeward along the cliffs near Kenidjack Castle, the ruins of which occupy a bold promontory a little to the north of Cape Cornwall. They had just come in sight of the tin-mine and works which cover Nancharrow valley from the shore to a considerable distance inland, where stand the tall chimneys and engine-houses, the whims and varied machinery of the extensive and prolific old tin-mine named Wheal Owles.

The cliffs on which the two men stood are very precipitous and rugged—rising in some places to a height of about 300 feet above the rocks where the waters of the Atlantic roll dark and deep, fringing the coast with a milky foam that is carried away by the tide in long streaks, to be defiled by the red waters which flow from Nancharrow valley into Porth Ledden Cove.

This cove is a small one, with a narrow stripe of sand on its shore. At its northern extremity is a deep narrow gorge, into which the waves rush, even in calm weather, with a peculiar sound. In reference to this it is said that the waves "buzz-and-go-in," hence the place has been named Zawn Buzzangein. The sides of the Zawn are about sixty feet high, and quite precipitous. In one part, especially, they overhang their base. It was here that Maggot and his friend stopped on their way home, and turned to look out upon the sea.

"No sign o' pilchers yet," observed Maggot, referring to the immense shoals of pilchards which visit the Cornish coasts in the autumn of each year, and form a large portion of the wealth of the county.

"Too soon," replied John Cock.

"By the way, Jack," said Maggot, "wasn't it hereabouts that the schooner went ashore last winter?"

"Iss, 'twor down theer, close by Pullandeese," replied the other, pointing to a deep pool in the rocks round which the swell of the Atlantic broke in white foam. "I was theere myself. I had come down 'bout daylight—before others were stirring, an' sure 'nuff there she lay, on the rocks, bottom up, an' all the crew lost. We seed wan o' them knackin' on the rocks to the north, so we got ropes an' let a man down to fetch un up, but of coorse it was gone dead."

"That minds me, Jack," said Maggot, "that I seed a daw's nest here the last time I come along, so lev us go an' stroob that daw's nest.

"Thee cusn't do it," said John Cock.

Maggot laughed, and said he not only could but would, so he ran down to the neighbouring works and returned with a stout rope, which he fixed firmly to a rock at the edge of the overhanging cliff.

We have already said that Maggot was a noted mad-cap, who stuck at nothing, and appeared to derive positive pleasure from the mere act of putting his life in danger. No human foot could, by climbing, have reached the spot where the nest of the daw, or Cornish chough, was fixed—for the precipice, besides being perpendicular and nearly flat, projected a little near the top, where the nest lay in a crevice overhanging the surf that boiled and raged in Zawn Buzzangein. Indeed, the nest was not visible from the spot where the two men stood, and it could only be seen by going round to the cliffs on the opposite side of the gorge.

Without a moment's hesitation Maggot swung himself over the edge of the precipice, merely cautioning his comrade, as he did so, to hold on to the rope and prevent it from slipping.

He slid down about two yards, and then found that the rock overhung so much that he was at least six feet off from the crevice in which the young daws nestled comfortably together, and no stretch that he could make with his legs, long though they were, was sufficient to enable him to get on the narrow ledge just below the nest. Several times he tried to gain a footing, and at each effort the juvenile daws—as yet ignorant of the desperate nature of man—opened their little eyes to the utmost in undisguised amazement. For full five minutes Maggot wriggled and the daws gazed, and the anxious comrade above watched the vibrations and jerks of the part of the rope that was visible to him while he listened intently. The bubbles on Zawn Buzzangein, like millions of watery eyes, danced and twinkled sixty feet below, as if in wonder at the object which swung wildly to and fro in mid-air.

At last Maggot managed to touch the rock with the extreme point of his toe. A slight push gave him swing sufficient to enable him to give one or two vigorous shoves, by which means he swung close to the side of the cliff. Watching his opportunity, he planted both feet on the narrow ledge before referred to, stretched out his hands, pressed himself flat against the rock, let go the rope, and remained fast, like a fly sticking to a wall.

This state of comparative safety he announced to his anxious friend above by exclaiming—

"All right, John—*I've* got the daws."

This statement was, however, not literally true, for it cost him several minutes of slow and careful struggling to enable him so to fix his person as to admit of his hands being used for "stroobing" purposes. At length he gained the object of his ambition, and transferred the horrified daws from their native home to his own warm but unnatural bosom, in which he buttoned them up tight. A qualm now shot through Maggot's heart, for he discovered that in his anxiety to secure the daws he had let go the rope, which hung at a distance of full six feet from him, and, of course, far beyond his reach.

"Hallo! John," he cried.

"Hallo!" shouted John in reply.

"I've got the *daws*," said Maggot, "but I've lost the *rope!*"

"Aw! my dear," gasped John; "have 'ee lost th' rope?"

"Iss."

It need scarcely be said that poor John Cock was dreadfully alarmed at this, and that he eagerly tendered much useless advice—stretching his neck the while as far as was safe over the cliff.

"I say, John," shouted Maggot again.

"Hallo!" answered John.

"I tell 'ee what: I'm goin' to jump for th' rope. If I do miss th' rope, run thee round to Porth Ledden Cove, an tak' my shoes weth 'ee; I'll be theere before 'ee."

Having made this somewhat bold prediction, Maggot collected all his energies, and sprang from his narrow perch into the air, with arms and hands wildly extended. His effort was well and bravely made, but his position had been too constrained, and his foothold too insecure, to admit of a good jump. He missed the rope, and, with a loud cry, shot like an arrow into the boiling flood below.

John Cock heard the cry and the plunge, and stood for nearly a minute gazing in horror into Zawn Buzzangein. Presently he drew a deep sigh of relief, for Maggot made his appearance, manfully buffeting the waves. John watched him with anxiety while he swam out towards the sea,—escaped the perpendicular sides of the Zawn, towards which the breakers more than once swept him, doubled the point, and turned in towards the cove. The opposite cliffs of the gorge now shut the swimmer out from John's view, so he drew another deep sigh, and picking up his comrade's shoes, ran round with all his might to Porth Ledden Cove, where, true to his word, having been helped both by wind and tide, Maggot had arrived before him.

"Are 'ee safe, my dear man?" was John's first question.

"Iss," replied Maggot, shaking himself, "safe enough, an' the daws too, but semmen to me they've gone dead."

This was too true. The poor birds had perished in their captor's bosom.

CHAPTER XIV.

CONTINUES TO TREAT OF SPIRITS, AND SHOWS THE VALUE OF HOSPITALITY.

HAVING accomplished the feat narrated in the last chapter, Maggot proceeded with his friend toward the town. On their way they had to pass the mouth of an old shaft in which both of them chanced to be much interested at that time, inasmuch as it contained the produce of a recent smuggling expedition on a large scale, consisting of nearly a hundred tubs of brandy. The liquor had been successfully brought ashore and concealed in the mine, and that night had been fixed on for its removal. Mules had been provided, and about fifty men were appointed to meet at a certain spot, at a fixed hour, to carry the whole away into the neighbouring towns.

Maggot and his comrade began to converse about the subject that was uppermost in their minds, and the former increased his pace, when John Cock drew his attention to the fact that the sun was getting low.

"The boys will be mustering now," said John, "an' them theere daws have kep' us late enough already."

"They do say that the boatsmen are informed about the toobs," observed Maggot.

"More need to look alive," said John.

"Hallo!" exclaimed Maggot suddenly; "there's some wan in the shaft!"

He pointed to a neighbouring mound of rubbish, on which, just as he spoke, a man made his appearance.

Without uttering a word the smugglers sauntered towards the mound, assuming a careless air, as though they were passing that way by chance. On drawing near they recognised Ebenezer Trezise, the coast-guard-man.

"Good hevening, sur," said Maggot; "seinmen as if you'd found a keenly lode."

"Why, iss, we've diskivered a noo vein," said Trezise, with a sly smile· "and we're sinkin' a shaft here in the hope o' raisin' tin, or *somethin'*."

"Ha! hope you'll let John an' me have a pitch in the noo bal, won't 'ee?" said Maggot, with a laugh.

"Oh, cer'nly, cer'nly," replied the boatsman; "if you'll lend us a hand to sink the shaft. You appear to have been in the water, and 'twill warm 'ee."

"No, thank 'ee," replied Maggot; "I've bin stroobin' a daw's nest under cliff, an' I fell into the say, so I'm goin' hum to dry myself, as I'm afeared o' kitchin' cold, being of a delikit constitootion. But I'll p'raps lend thee a hand afterwards."

Maggot nodded as he spoke, and left the place at a slow saunter with his comrade, followed by the thanks and good-wishes of the boatsman, who immediately returned to the laborious task of clearing out the old shaft.

"They've got the scent," said Maggot, when out of ear-shot; "but we'll do 'em yet. Whenever thee gets on the lee-side o' that hedge, John, do 'ee clap on all sail for Balaswidden, where the boys are waitin', an' tell 'em to be ready for a call. I'll send Zackey, or wan o' the child'n to 'ee."

John went off on his errand the moment he was out of sight of the boatsmen, and Maggot walked smartly to his cottage.

"Owld ooman," he said, commencing to unbutton his wet garments, "do 'ee git ready a cup o' tay, as fast as you can, lass; we shall have company to-night."

"Company!" exclaimed Mrs. Maggot in surprise; "what sort o' company?"

"Oh! the best, the best," said Maggot, with a laugh; "boatsmen no less, so look sharp. Zackey oooy, come here."

Zackey put down the unfortunate black kitten (which immediately sought comfort in repose) and obeyed his father's summons, while his mother, knowing that her husband had some plot in his wise head, set about preparing a sumptuous meal, which consisted of bread and butter, tea and fried mackerel. and Cornish pasty.

"Zackey, my son," said Maggot, while he continued his toilet.

"Iss, father."

"I want 'ee to come down to the owld shaft with me, an' when I give 'ee the word cut away as hard as thee legs can spank to Balaswidden, an' fetch the lads that are theere to the owld shaft. They knaw what to do, but tell 'em to make so little noise as they can. Dost a hear, my son?"

"Iss, faither," replied Zackey, with a wink of such profound meaning that his sire felt quite satisfied he was equal to the duty assigned him.

"Now, doan't 'ee wag tongue more than enough," continued Maggot; "and go play with the chet till I 'm ready."

The urchin at once descended like a thunderbolt on the black kitten, but that marvellous animal had succeeded in snatching five minutes' repose, which seemed to be amply sufficient to recruit its energies, for it began instantly to play—in other words to worry and scratch the boy's hand—with the utmost glee and good-humour.

In a few minutes Maggot and his son went out, and hastened to the old shaft, where they found the boatsmen still hard at work with pick and shovel clearing away the rubbish.

"You haven't found a bunch o' copper yet, I dessay?" said Maggot, with a grin.

"No, not yet, but we shan't be long," replied Eben Trezise, with a knowing smile.

"It 's warm work," observed Maggot, as he looked down the hole, and saw that what the boatsman said was true, and that they would not be long of reaching the spot where the liquor had been concealed.

Trezise admitted that it *was* warm work, and paused to wipe his heated brow.

"I wish we had a drop o' water here," he said, looking up.

"Ha!" exclaimed Maggot; "not much chance o' findin' water in *that* hole, I do think—no, nor brandy nuther."

"Not so sure o' that," said Trezise, resuming his work.

"Now, et *is* a shame to let 'ee die here for want of a drop o' water," said Maggot in a compassionate tone; "I 'll send my booy hum for some."

The boatsmen thanked him, and Zackey was ordered off to fetch a jug of water; but his father's voice arrested him before he had gone a hundred yards.

"Hold on a bit, my son.—P'raps," he said, turning to Trezise, "you'd come up hum with me and have a dish o' tay? Missus have got it all ready."

The invitation appeared to gratify the boatsmen, who smiled, and winked at each other, as though they thought themselves very clever fellows to have discovered the whereabouts of a hidden treasure, and to be refreshed in the midst of their toil by one whom they knew to be a noted smuggler, and whom they strongly suspected of being concerned in the job they were at that time endeavouring to frustrate. Throwing down their tools they laughingly accepted the invitation, and clambered out of the shaft.

"Now's your time," whispered Maggot, with a nod to his hopeful son, and then added aloud—

"Cut away, Zackey booy, an' tell mother to get the tay ready. Run, my son, let us knaw what thee legs are made of."

"He's a smart lad," observed Trezise, as Zackey gave his father an intelligent look, and dashed away at the top of his speed.

"Iss, a clever cheeld," assented Maggot.

"Bin down in the mines, I dessay?" said Trezise.

"Iss, oh iss; he do knaw tin," replied Maggot with much gravity.

In a few minutes the two coast-guard-men were seated at Mrs. Maggot's well-supplied board, enjoying the most comfortable meal they had eaten for many a day. It was seasoned, too, with such racy talk, abounding in anecdote, from Maggot, and such importunate hospitality on the part of his better half, that the men felt no disposition to cut it short. Little Grace, too, was charmingly attentive, for she, poor child, being utterly ignorant of the double parts which her parents were playing, rejoiced, in the native kindliness of her heart, to see them all so happy. Even the "chet" seemed to enter into the spirit of what was going on, for, regardless of the splendid opportunity that now presented itself of obtaining repose to its heart's content, that black ball of concentrated essence of mischief dashed wildly about the floor and up the bed-curtains, with its back up and its tail thickened, and its green eyes glaring defiance at everything animate, inanimate, or otherwise, insomuch that Maggot made sundry efforts to quell it with the three-legged stool—and Mrs. Maggot followed suit with a dish-clout—but in vain!

Meanwhile, men and mules and horses were converging by many paths and lanes towards the old shaft, and the shaft itself was apparently endued with the properties of a volcano, for out of its mouth issued a continuous shower of dust and stones, while many stalwart arms laid bare the mine beneath, and tossed up the precious "tubs" of brandy.

Before the pleasant little tea-party in Maggot's cottage broke up the whole were scattered abroad, and men and mules and horses sped with their ill-gotten gains across the furze-clad moors.

"Sure it 's early to break up," said Maggot, when the boatsmen at last rose to take their leave; "there 's no fear o' the bunches o' copper melting down there, or flyin' away."

"There's no saying," replied Eben Trezise; "you've heerd as well as we of lodes takin' the bit in their teeth an' disappearing—eh?"

"Well, iss, so they do sometimes; I 'll not keep 'ee longer; good hevenin' to 'ee," said Maggot, going outside the door and wishing them all manner of success as they returned to the old shaft.

Reader, shall we follow the two knowing fellows to that shaft? Shall we mark the bewildered expression of amazement with which they gazed into it, and listen to the wild fiendish laugh of mingled amusement and wrath that bursts from them in fitful explosions as the truth flashes into their unwilling minds? No; vice had triumphed over virtue, and we deem it a kindness to your sensitive nature to draw a veil over the scene of her discomfiture.

CHAPTER XV.

INTRODUCES A STRANGER, DESCRIBES A PIC-NIC, AND REVEALS SOME SECRETS OF MINING.

Somewhere in the vicinity of that magnificent piece of coast scenery in West Cornwall, known by the name of Gurnard's Head, there sauntered, one fine afternoon, a gentleman of tall commanding aspect. All the parts of this gentleman were, if we may so speak, *prononcé.* Everything about him savoured of the superlative degree. His head and face were handsome and large, but their size was not apparent because of the capacity of his broad shoulders and wide chest. His waist was slender, hair curly and very black, only to be excelled by the intense blackness of his eyes. His nose was prominent; mouth large and well shaped; forehead high and broad; whiskers enormous; and nostrils so large as to appear dilated. He was a bony man, a powerful man—also tall and straight, and a little beyond forty. He was to all appearance a hero of romance, and his mind seemed to be filled with romantic thoughts, for he smiled frequently as he gazed around him from the top of the cliffs on the beautiful landscape which lay spread out at his feet.

Above him there were wild undulating slopes covered with rich green gorse; below were the cliffs of Gurnard's Cove, with rocky projections that resemble the castellated work of man's hand, and, intermingled therewith, much of the *matériel* connected with the pilchard fishery, with masses of masonry so heavy and picturesque as to resemble Nature's handiwork. Beyond lay the blue waves of the Atlantic, which at that time were calm almost as a mill-pond, studded with a hundred sails, and glittering in sunshine.

The spot appeared a beautiful solitude, for no living thing was visible save the romantic gentleman and a few sea-gulls and sheep. The pilchard fishery had not yet commenced, and the three or four fishermen who pitched and repaired their boats on the one little spot of sand that could be seen far below on that rugged coast, appeared like mice, and were too far distant to break the feeling of solitude —a feeling which was not a little enhanced by the appearance, on a spot not far distant, of the ruined engine-house of a deserted mine.

It was indeed a lovely afternoon, and a beautiful scene—a very misanthrope would have gazed on it with an approach at least to benignity. No wonder that George Augustus Clearemont smiled on it so joyously, and whisked his walking-cane vigorously in the exuberance of his delight.

But, strange to say, his smile was always brightest, and the cane flourished most energetically, when he turned his eyes on the ruined mine! He even laughed once or twice, and muttered to himself as he looked at the picturesque object; yet there seemed nothing in its appearance calculated to produce laughter. On the contrary, there were those alive whom the sight of it might have reduced to tears, for, in its brief existence, it had raised uncommonly little tin or copper, although it had succeeded in sinking an immense amount of gold! Nevertheless Mr. Clearemout chuckled every time he looked at the ruin, and appeared very much tickled with the thoughts to which it gave rise.

"Yes! the very thing! capital!" he muttered to himself, turning again and again to the object of his admiration, "couldn't be better—ha! ha! most suitable; yes, it will do for 'em, probably it will *do* 'em—do 'em" (he repeated the phrase two or three times with a greater display of white teeth at each utterance of it), "a most superb name—Wheal Do-em—ha! ha! Spell it with two o's to make it look more natural, and insure correct pronunciation—Wheal Dooem—nothing could be finer, quite candid and above-board—no one can call it a swindle."

This last idea caused Mr. Clearemout to break into the loudest laugh in which he had hitherto indulged, and he was about to repeat it, when the appearance of a phaeton at a turn of the carriage-road reduced him to gravity.

The vehicle contained a party of ladies and gentlemen from St. Just, among whom were Rose Ellis, Mrs. Donnithorne and her husband, Oliver Trembath, and Mr. William Grenfell, a gentleman of property in the neighbourhood.

As it approached the spot where Mr. Clearemout stood, the horse swerved at a sheep which started out from behind a furze bush, and then backed so rapidly that the hind-wheels were on the point of passing over the edge of the road, when the tall stranger sprang to its head, and led it gently forward.

The danger was not great, for the road at the place was elevated little above the sward, but it was sufficiently so to warrant a profusion of thanks from the occupants of the vehicle, and a pressing invitation to Mr. Clearemout to join the pic-nic party then and there assembling.

"You see, we're not all here," said Mr. Donnithorne, bustling about energetically, as he pulled baskets and bottles from the body of the vehicle, while Oliver assisted the ladies to alight; "there's another machineful coming, but we have lots of grub for all, and will only be too glad of your company, Mr.— Mr.— what did you say?"

"Clearemout," interposed that gentleman, with a bow and a bland smile that quite took Mr. Donnithorne by storm.

"Ah, yes, glad to have you, Mr. Clearemout: why, our necks might all have been broken but for you. Rose, my dear, do look after this basket. There—thanks—how hot it is, to be sure! Mr. Clearemout—Mr. Grenfell; no introduction—only to let you know his name—my wife—niece, Rose—Oliver Trembath, and all the rest; there, dispense with ceremony on a pic-nic always. That's the chief fun of it."

While the lively old gentleman ran on thus, and collected the baskets together, Mr. Grenfell, who was a tall, gentlemanly man of about sixty, with a grave, aristocratic countenance and polite manner, assured Mr. Clearemout that he was happy to make the acquaintance of a man who had rendered them such opportune service, whereupon Mr. Clearemout declared himself to be fortunate in being present at such a juncture, and protested that his service was a trifle in itself, although it led to an introduction which was most gratifying. Then, turning with much urbanity of manner to the ladies, he entered into conversation with them.

"Here they come!" shouted old Mr. Donnithorne as another carriage drove up.

"The rest of our party," said Mr. Grenfell, turning to Mr. Clearemout; "friends from St. Just."

The carriage stopped as he spoke, and a number of ladies and gentlemen descended therefrom, and mingled their congratulations at the narrow escape which had just been made, with thanks to the dark stranger, and with orders, question, counter-orders, and explanations innumerable, about baskets to be carried and places to be selected.

The pic-nic, we need scarcely say, very much resembled pic-nics in general. All were in good spirits—elated with the splendour of the day, the beauty of the views, and the freshness of the sea-breeze that sprang up soon after their arrival. The only one whose feelings were not absolutely unruffled was Oliver Trembath. That youth was afflicted with an unaccountable dislike to the dark stranger, which rendered him somewhat uncomfortable. As for the stranger himself, he made himself extremely agreeable—told anecdotes, sang songs, and became an immaculate waiter on the whole company, handing about plates, glasses, knives, etc. etc., as deftly as if he were dealing a pack of cards. Above all, he was a good listener, and not only heard other people's stories out to the end, but commented on them as one who had been interested. With all this, he was particularly attentive to Rose Ellis, but so guarded was he that no one noticed the attentions as being peculiar except Rose herself, and Oliver Trembath, who, for the first time in his life, to his great surprise and displeasure, felt the demon of jealousy tormenting his breast.

But in the midst of all this, Mr. George Augustus Clearemout displayed an insatiable curiosity in regard to mines and miners. Whatever might be the subject of conversation for the time, he invariably took the first opportunity of returning to his favourite theme with one or another of the party, as occasion served.

Ashamed of the feelings which troubled him, Oliver Trembath resolved to take the bold and manly step of stifling them, by making himself agreeable to the object of his dislike. Accordingly, he availed himself of an opportunity when the party broke up into groups to saunter about the cliffs, and entered into converse with the stranger on the subject of mines.

"You appear to take much interest in mining, I think," said he, as they walked out on the promontory together.

"I do indeed," replied Clearemout; "the mines of Cornwall have ever been a subject of deep interest to me, and the miners I regard as a race of men singularly endued with courage and perseverance."

"Your opinion of them is correct," said Oliver. "Have you ever seen them at work?"

"No, I have only just arrived in the country, but I hope to visit the mines ere long."

"When you do," said Oliver, with enthusiasm, "your opinion of them will be strengthened, for their endurance underground, and their perseverance in a species of labour which taxes their muscular power as well as their patience to the uttermost, surpasses anything I have either seen or heard of. England does not fully appreciate, because she is not minutely acquainted with, the endurance and courage of her Cornish miners. The rocks through which they have to cut are so hard and unyielding that men who had not been trained from childhood to subdue them, would lose heart altogether at the weight of toil and the small return for it. Sometimes, indeed, miners are fortunate, and here, as elsewhere, lucky hits are made, but for the most part their gains are barely sufficient for their wants, and whether they are lucky or unlucky in that respect, the toil is always hard—so hard that few of them retain health or strength sufficient to go underground beyond the age of forty-five, while hundreds of them find an early grave, owing to disease resulting from their peculiar work, or to accidents. These last are usually occasioned by the bursting out of collections of water which flood the mines; or the fall of masses of timber; or the premature explosion of blast-holes. At other times the men lose hold of the ladders—"fall away" from them, as they express it—or stumble into a winze, which is a small shaft connecting level with level, in which latter case death is almost certain to ensue, many of the winzes being sixty feet deep. In St. Just you will see many poor fellows who have been blinded and maimed in the mines. Nevertheless Cornish miners are a contented uncomplaining race of men, and Cornwall is justly proud of them."

"I am much interested in what you tell me," said Clearemout; "in fact I have come here for the purpose of making inquiry into mines and mining concerns."

"Then you will find this to be the very place for you," said Oliver. "My uncle, Mr. Donnithorne, and Mr. Grenfell, and Mr. Cornish, are intimately acquainted with mining in all its phases, and will, I am certain, be happy to give you all the information in their power. As to the people of St. Just and its neighbourhood, you will find them most agreeable and hospitable. I can speak from personal experience, although I have only been a short time among them."

"I doubt it not," replied Mr. Clearemout with a bland smile; "my own limited experience goes far to corroborate what you say, and I hope to have the pleasure of still further testing the truth of your observations."

And Mr. George Augustus Clearemout did test their truth for several weeks after the pic-nic. He was received with kindness and hospitality everywhere; he was taken down into the mines by obliging agents, and was invited to several of the periodical business dinners, called "account dinners," at which he met shareholders in the mines, and had an opportunity of conversing with men of note and wealth from various parts of the country. He dwelt, during his stay, with old Mr. Donnithorne, and, much to the surprise if not pleasure of Rose, proved himself to be a proficient on the guitar, and a good musician.

At length the dark gentleman took his departure for London, whither we shall follow him, and watch his proceedings for a very short time, before returning to the principal scene of our tale.

Almost immediately on his arrival in the great city, he betook himself to the West-end, and there, in a fashionable square, solicited an interview with an old lady, whose principal noteworthy points were that she had much gold and not much brains. She was a confiding old lady, and had, on a previous occasion, been quite won by the insinuating address of the "charming Mr. Clearemout," who had been introduced to her by a noble lord.

To this confiding old lady George Augustus painted Cornish mines and mining in the most glowing colours, and recommended her to invest in a mine a portion of her surplus funds. The confiding old lady had no taste for speculation, and was rather partial to the three per cent. consols, but George Augustus was so charmingly persuasive that she could not help giving in—so George proposed little plans, and opened up little prospects, and the confiding old lady agreed to all the little plans without paying much regard to the little prospects.

After this Mr. Clearemout paid another visit in another West-end square—this time to a gentleman. The gentleman was young and noble, for Clearemout styled him "My Lord." Strange to say he also was of a confiding nature—very much so indeed—and appeared to be even more completely under the influence of George Augustus than the confiding old lady herself.

For the benefit of this young gentleman Mr. Clearemout painted the same picture in the same glowing colours, which colours seemed to grow warmer as the sun of success rose upon it. He added something about the value of a name, and referred to money as being a matter of small consequence in comparison. The young lord, like the old lady, agreed to everything that was proposed to him, except the proposal to advance money. On that point he was resolute, but Clearemout did not care much about obtaining money from the confiding young gentleman. His name was as good as gold, and would enable him to screw money out of others.

After this the dark man paid a visit to several other friends at the West-end, all of whom were more or less confiding—some with selfish, others with unselfish, dispositions—but all, without exception, a little weak intellectually. These had the same glowing picture of a Cornish mine laid before them, and most of them swallowed the bait whole, only one or two being content to nibble.

When afternoon began to merge into evening Mr. Clearemout paid a last visit for the day—but not in the West-end, rather nearer to the City—to a gentleman somewhat like himself, though less prepossessing, for whose benefit he painted no glowing picture of a mine, but to whom he said, "Come, Jack, I've made a pretty good job of it, let's go and have a chop. If your luck has equalled mine the thing is done, and Wheal Dooem, as I have named the sweet little thing, will be going full swing in a couple of weeks—costing, perhaps, a few hundreds to put it in working order, with a trifle thereafter in the shape of wages to a man and a boy to coal the fire, and keep the thing moving with as much noise as possible to make a show, and leaving a pretty little balance of some twenty or thirty thousand at the credit of the Company, for you and me to enjoy in the meantime—*minus* a small sum for rent of office, clerk's salary, gas and coal, etc., as long as the bubble lasts."

Thus did this polite scoundrel go about from house to house getting up a Cornish Mining Company on false pretences (as other polite scoundrels have done before, and doubtless as others will do again), bringing into unmerited disrepute those genuine and grand old mines of Cornwall which have yielded stores of tin and copper, to the enriching of the English nation, ever since those old-world days when the Phœnicians sailed their adventurous barks to the "Cassiterides" in quest of tin.

While these things were being done in London, a terrible catastrophe happened in Botallack mine, which threw a dark cloud for some time over more than one lowly cottage in St. Just.

CHAPTER XVI.

DESCRIBES "HOLING TO A HOUSE OF WATER" AND ITS TERRIBLE CONSEQUENCES.

ONE morning, about seven o'clock, George and James, the two fair-haired sons of poor John Batten of Botallack, started for their work as usual. They were in high spirits, having obtained a good "pitch" on last setting-day, and things were looking well.

They put on their underground clothing at the changing-house, and with several spare candles attached to buttons on the breasts of their coats, and their tools slung over their shoulders, walked towards the head of the ladder-shaft. At the mouth of the shaft they paused for a moment and glanced round. The sky was bright, the landscape green, and the sun lit up many a distant sail on the Atlantic.

"I do wish," said the younger, with a slight sigh, "that our work was more in the sunshine."

"You 'll never be a true miner, Jimmy, if 'ee go hankerin' after the sun like that," said his brother, with a laugh, as he stepped on the ladder and began to descend.

Jimmy took a last look at the rising sun, and followed him close without replying. The lads were soon beyond the reach of daylight.

This was the last they ever saw of earthly sunshine. In a few minutes there came a low soft sound up the shaft; it was the lads singing one of Wesley's beautiful hymns. They had been taught to sing these by their mother from their infancy, and usually beguiled the tedium of the long descent of the ladders by singing one or two of them.

Arrived at their place of work the brothers threw down their tools, fixed their candles against the walls of the level, and began the labour of the day.

Other men were in that part of the mine at the time, and the brothers found that a message had been sent to one of the captains requesting him to come and examine the place, as the men were becoming uneasy at the increasing flow of water from the walls. One miner, named John Nicols, was "driving an end," that is, extending the level lengthwise, and two others were "stopeing," or cutting, up into the roof in pursuit of a promising little lode. They were using hammer and pick in soft ground when the water trickled through to them.

It was well known that they were approaching old part of the mine which had not been worked thirty years. The drainage of the ground was not, however, accurately known, therefore questions had been put to experienced miners as to the probable condition of this "untapped land." The answer was, that as far as was known, the old mine was full of "deads," that is, of rubbish, and that there was therefore, in all probability, no gathering of water in it.

Just at that moment one of the captains entered the level, accompanied by Oliver Trembath. The latter had been called to see a patient near the mine, and chanced to be with the captain when he was summoned. Being anxious to see the place, and the nature of the danger that threatened, he had descended along with him.

Before the captain had time to put a question, and while the men were still picking cautiously at the soft ground, the flow of water suddenly increased. Recognising probable danger, a lad named Oats called to his father, who was at the "end" of the level with Nicols. At the same moment the water forced a gap in the wall three feet long, by about half a foot wide, and burst in upon them with terrific violence. All turned and fled. Oats and his son, with the captain and Nicols, made for the nearest shaft—which was about eighty yards distant—and escaped, but the brothers Batten and Oliver were thrown down and swept away. One desperate effort was made by Oliver to outstrip the rushing stream, but the candles had been blown out, and, not stooping sufficiently low, he dashed his head against an overhanging rock, and fell. He retained sufficient consciousness, however, to be aware that a desperate struggle for life must be made, and, without knowing what he did, or at what he aimed, he fought with the strength of a giant in thick darkness against the chaotic flood; but his strength soon gave way, and in a few seconds he became insensible.

That a terrible catastrophe had occurred was at once known to all the men in the mine by the roar of the rushing water. In order that the reader may clearly understand the situation, it is necessary to explain that the accident occurred in one of the *upper* levels, at or near its extremity. At the same depth there were many of these underground passages, running in various directions, and several miles in extent, some of them being worked, but most of them old and used up—all the ore having been extracted from them. At various depths below this level other levels had been cut—also running in various directions, and of several miles' extent. These successive levels were not only connected and communicated with by the main shafts of the mine, but by "winzes" or smaller shafts which connected level with level in many places. Some of these were used as ladder-ways, but others had been cut merely for the purpose of securing ventilation. In many parts of these lower levels miners were at work—some, in following the course of promising lodes, "stopeing," or cutting overhead, some cutting downwards, some "driving ends," or extending the levels, and others sinking winzes to keep up the ventilation as they pushed farther and farther from the shafts or throats, down which flowed the life-giving air.

By all of these men the dreaded sounds above—which reached the profounder depths with the muffled, but deep-toned, roar of a distant storm—were well understood and well heard, for the pent-up waters, in their irresistible fury, carried before them the pent-up atmosphere, and sent it through the low and narrow levels as if through the circling tubes of a monster trumpet, which, mingled with the crash of hurling timbers, rocks, and *débris*, created a mighty roar that excelled in hideous grandeur the prolonged peals of loud thunder.

Every man dropped his tools, and ran to the nearest shaft for his life. It was not, indeed, probable that the flood would fill all the wide-extended ramifications of the vast mine, but no one knew for certain where the catastrophe had occurred, or how near the danger might be to the spot where he laboured. Enough for each that Death was dealing terrible destruction somewhere *overhead*, and that, unless every muscle were strained to the uttermost, the pathway might be filled up, and his retreat cut off.

The rush was swiftly, but not easily made. Those who have never traversed the levels of a Cornish mine may perhaps fancy, on hearing of levels six feet high, and about two and a half feet broad, on the average, that the flight might resemble the rush of men through the windings and turnings of the intricate passages in a stupendous old castle. But it was far otherwise. The roofs, walls, and floors of these levels were irregular, not only in direction, but in height and form. There was no levelling or polishing-off anywhere. It was tunnelling of the roughest kind. Angles and projections remained as the chisel, the pick, and the blasting-powder had left them. Here, the foot tripped over a lump, or plunged into a hollow; there, the head narrowly missed a depending mass of rock, or the shoulder grazed a projecting one. Elsewhere, pools of water lay in the path, and at intervals the yawning chasm of a winze appeared, with one or two broken planks to bridge the gulf, of twenty, forty, or sixty feet, that descended to the levels below. Sometimes it was possible to run with the head stooped a little; generally the back had to be bent low,—often double; and occasionally progress could only be made on hands and knees,—this, too, with a candle to be guarded from blasts of air or dripping water, and trimmed, lest it should go out and leave the place in total darkness.

But long-continued habit and practice had made the men so familiar with the place, and so nimble in their movements, that they traversed the levels with wonderful rapidity, and most of them ascended the shafts of the mine in safety.

Some, however, escaped with the utmost difficulty, and a few there were—chiefly among those who had been near to or immediately below the scene of the outbreak—who perished miserably.

At the first rush the water had almost filled the level where it occurred, and, sweeping onward about eight fathoms to a winze plunged down and partly over it. The greater part, however, went down to the eighty-five fathom level. East of this a man named Anguin, with his two sons, William and James—youths of about twenty years of age—were at work. They heard the roar of the approaching torrent, and the father and younger son James, rushed towards the winze, intending to ascend the ladder. Before they reached it the flood was pouring down with deafening noise. The least harmful part of the cataract was the water, for the current now carried along with it stones, pieces of timber, and rubbish. To encounter all this might have caused the stoutest hearts to quail, but miners can never calculate the probable extent of an inundation. They might, indeed, by remaining in the roof of the level, escape; but, on the other hand, if the flood should be great enough to fill the place, they would certainly be drowned. Father and son, therefore, preferred to make a desperate effort to save their lives. They dashed into the flood and made a grasp at the ladder, but before their hands touched the first round they were beaten down and swept away dead corpses. William, on the other hand, climbed to a cross-piece of timber, where he remained until the water abated, which it did in a very short time, for events of this kind are for the most part awfully sudden, and brief as well as fatal. Then, descending, he groped his way in the dark over the very spot where his father and brother lay dead—fearfully mutilated and covered with rubbish—and escaped up the shaft.

In a still lower level two brothers were at work. Miners usually work in couples—sometimes in larger numbers,—and brothers frequently go together. They were in a winze about thirty fathoms from the engine-shaft. Being overtaken by the flood they were washed *down* to the next level, and along it nearly to the shaft. As the torrent tore past this place, bearing splintered timber, stones and rubbish along with it, an iron waggon was caught up and flung across the level. This formed a barricade, against which the brothers were dashed. The elder of these brothers was afterwards found alive here, and carried to the surface, but he was speechless, and died twenty minutes after being brought up. When the dead body of the younger and weaker brother was recovered, it was found to be dreadfully shattered, nearly every bone being crushed.

In the same level, two men—John Paul and Andrew Teague—hearing the rush of the advancing torrent above their head, made for a shaft, went up it against a heavy fall of water, and escaped.

A man named Richard—a powerful man and a cool experienced miner, who had faced death in almost every form,—was at work in one of the lowest levels with his son William (a youth of twenty-one) and his nephew, a lad of seventeen, who was the sole support of a widowed mother with six children. They were thirty fathoms from one of the winzes down which the water streamed. On hearing the roar Richard cautioned the younger men to be prompt, but collected. No time was to be lost, but rash haste might prove as fatal as delay. He sent them on in front of him, and they rushed under and past the winze, where they were nearly crushed by the falling water, and where, of course, their candles were extinguished, leaving them in midnight darkness. This last was not so serious a matter to the elder Richard as, at first sight, it might appear. He knew every foot of the ground they had to traverse, with all its turnings, yawning chasms and plank bridges, and could have led the way blindfold, almost as easily as with a light. As they neared the shaft, he passed the younger men, and led the way to prevent them falling into it. At this time the water raged round them as high as their waists. The nephew, who was weak, in consequence of a fever from which he had not quite recovered, fell, and, passing the others unobserved, went down the shaft and was lost. The escape of Richard and his son was most wonderful. William was a stout fellow, but the father much more so. They were driven at first into the shaft, but there the fall of water was so great that they could do nothing more than cling to the ladder. By this cataract they were beaten back into the level, but here the water rose around them so quickly and with such force as to oblige them to make another effort to ascend.

There was a crevice in the roof of the level here, in which the father had left part of his supply of candles and a tinder-box. He succeeded in reaching these, and in striking a light, which revealed to them the full horrors of their situation. It was with difficulty that the candle could be kept burning by holding it close to the roof under a projecting piece of rock, which sheltered it partially from the dashing spray.

"Let us try again!" shouted the father.

The noise was so great that it was with difficulty they could make each other hear.

"It's all over with we," cried the son; "let us pray, faither."

The father urgéd his son, however, to make another effort, as the water had risen nearly to their waists, and prevailed on him to do so, getting on the ladder himself first, in order to bear the brunt of the falling water and thus break its force to his son. As the water below was now rising swiftly William only held the light long enough to enable his father to obtain a secure footing on the ladder, when he dropped it and followed him. So anxious was the youth to escape from the danger that menaced him from below, that he pressed eagerly up against his father. In doing so, he over-reached the rounds of the ladder on which his father trod, and, almost at every step, the latter unwittingly planted his heavy-nailed boots on the son's hands, lacerating them terribly. To avoid this was impossible. So heavy was the descending flood, that it was only his unusually great strength which enabled the father to advance slowly up against it. The son, being partially sheltered by his father's body, knew not the power against which he had to contend, and, being anxious to go up faster, pressed too closely on him, regardless, in his alarm, of the painful consequences. Masses of stone, wood, and rubbish, dashed down the shaft and grazed their shoulders, but providentially none struck them severely. Thus, slowly and painfully, did they ascend to a height of eighty-four feet, and were saved.

In another part of the mine, below the level where the accident occurred, James Penrose, whom we have already introduced to the reader, was at work with John Cock. The latter having taken a fancy to try mining for a time instead of smuggling—just by way of a change—had joined the former in working a "pitch" in Botallack mine. These men were peculiarly situated. They were in a level which the water entered, not by flowing along or descending, but, by rising up through a winze. On hearing the noise, they ran to this winze, and, looking down, saw the water boiling and roaring far below. They were about to pass on to the shaft when Penrose observed a dark object moving on the ladder. It came slowly up.

"Hallo! John," cried Penrose, "stay a bit; here's some one on the ladder."

John Cock returned, and they both stooped to afford help. In another moment Oliver Trembath, drenched and bleeding, and covered with mud, stood, or rather reeled, before them. It was evident that he was only half conscious, and scarcely able to stand. But they had no time to speak—scarcely to think—for the water was already boiling up through the winze like a huge fountain, and filling the level; they seized Oliver by the arms and dragged him hastily towards the nearest winze that led upward. Here they found water pouring down like rain, and heard its thunders above them, but the stream was not sufficient to retard their progress up the winze, which they ascended with comparative ease. Penrose and Cock were surprised at this, but the small quantity of water was soon accounted for by the fact that the hatch or trap-door of the winze had been closed; and thus, while it prevented the great body of water above from descending, also effectually shut off the only way of escape. They were therefore compelled to descend again to the level, in which the water was now rising rapidly.

Oliver leaned against the rock, and stood in apathetic silence. Penrose tried to rouse him, but failed. His injuries had rendered him almost incapable of coherent speech, and his replies showed that his mind was rambling on the necessity of making haste and struggling hard.

James Penrose, who was a "class-leader" and a local preacher among the Wesleyans, and, mentally, much superior to his comrades, now proved beyond a doubt that his God was to him "a very present help in trouble." Both he and Cock knew, or at least believed, that death was certain to overtake them in a few minutes, for, both before and behind, retreat was cut off, and the water was increasing with frightful rapidity. Observing that Cock looked anxious, Penrose turned and said earnestly—

"John, you and I shall be dead in a few minutes. For myself I have no fear, for my peace is already made with God, through Jesus Christ—blessed be His name—but, oh! John, you do know that it is not so with you. Turn, John, turn, even now, to the Lord, who tells you that 'though thy sins be as scarlet they shall be white as snow,' and that '*now* is the day of salvation,' if you will only repent, and believe on Him!"

"Pray for un, James," said Cock, whose face betrayed his fears.

Penrose at once clasped his hands, and, closing his eyes, prayed for his comrade with such fervour that his voice rose loud and strong above the turmoil of the flood. He was still engaged in prayer when the water drove them from the level, and compelled them to re-ascend the winze. Here John Cock began to pray for himself in agonizing tones. By this time Oliver had partially recovered, and suggested that they should ascend the winze to the top. Penrose assured him that it was useless to do so, but, while he was still speaking, he observed that the water ceased to rise, and began quickly to abate. In fact, all that we have taken so long to describe—from the outburst to the termination of the great rush—took place within half an hour.

The noise overhead now grew less and less, until it almost ceased. They then ascended to the trap-door and tried to force it open, but failed. They shouted, however, and were heard, ere long, by those who had escaped and had returned to the mine to search for their less fortunate companions. The trap-door was opened, strong and willing hands were thrust down the dark winze to the rescue, and in a few seconds the three men were saved.

The danger was past—but five lives had been lost in the terrible catastrophe.

CHAPTER XVII.

TOUCHES ON THE CAUSES OF ACCIDENTS; SHOWS OLIVER IN A NEW LIGHT AND HIS UNCLE IN A SAD ONE.

THAT was a sad day in St. Just which followed the event related in the last chapter. Many a heart-broken wail was heard round the mouths of the shafts, as the remains of those who perished were brought to the surface, and conveyed to their former homes.

Saddest of all perhaps was the procession that marched slowly to the cottage of blind John Batten, and laid the two fair-haired lads before their stricken parents. Tears were wrung from the strongest men there when they beheld the agonized but tearless mother guide her husband's hand to their faces that he might for the last time feel the loved ones whom, she said in the bitterness of her grief, "he should never see more."

"Never see more, dear lass!" he replied, with a sad smile, "how can thee say so? Shall we not behold their dear faces again when we see our blessed Lord face to face?"

Thus the Christian miner comforted himself and his sorrowing family.

It is right to add that such catastrophes are not of frequent occurrence in the mines. The danger of "holing to a house of water" is so great and so well known that the operation is usually conducted with great care, and accident is well guarded against.

Nevertheless, an occasional act of carelessness will now and then result in a terrible disaster. A catastrophe, similar in all its chief features to that which has been related in the last chapter, happened in North Levant mine about two years ago, and in the burying-ground of the Wesleyan Chapel of St. Just may be seen a tombstone, which bears record of the sad event as follows:—

> *Sacred to the memory of* JAMES, *aged* 20, *and* JOHN, *aged* 15 *years, sons of James and Nanny Thomas of Bollowall, in this Parish, who were drowned (with three others) by the holing to a house of water in North Levant Mine on the* 1*st of April* 1867.

A "house" of much larger dimensions, and containing a much greater body of water than that which caused the latest destruction of life in North Levant mine, was cleared of water not long ago, in Botallack. The agents knew of its existence, for, the whole region both above and below ground being measured off and planned, they could lay their finger on the exact spot where they knew that an old mine existed. They kept a large borer, six feet long, going constantly before them as they cut their way towards the point of danger. The result was that when the borer at last pierced through to the old mine, there were six feet of solid rock between them and the water. Through the small hole the water flowed, and thus the mine was slowly but safely drained. In the other case, the ground happened to be soft, and had been somewhat recklessly cut away.

Of course, there are occasions—proving the truth of the proverb that "accidents will happen in the best regulated families"—in which neither foresight nor precaution can prevent evil; but these are comparatively few. Sometimes the cupidity of a miner will lead him, for the sake of following a rich lode, to approach too near and too recklessly to danger, despite the vigilance of captains, and cause considerable risk to the mine as well as to themselves. Such was the case once, long ago, at Botallack, when the miners below the sea cut away the rock to within three or four feet of the water, and actually made a small hole through so that they had to plug it up with a piece of wood.

This is a fact which we can vouch for, having seen the plug, and heard the boulders rattling loudly over our head with each successive wave; but there is no danger here, because the cutting under the sea is narrow, and the rock solid and intensely hard.

Such also was the case, within the present year, at Levant mine, where the men working in the levels under the sea drove upwards until the salt water began to trickle through to them in alarming quantities—insomuch that the other miners struck work, and refused to go again into the mine, unless the workings in that part were stopped, and the place made secure. This was accordingly done, and the men returned to the mine. The danger here was really great, because the cutting that had been made was wide, and the ground overhead comparatively soft.

But, to return to our tale:—

For many days after the catastrophe Oliver Trembath lay in his bed suffering from severe cuts and bruises, as well as from what must have been, as nearly as possible, concussion of the brain, for he had certainly been washed down one of the winzes, although he himself retained only a confused recollection of the events of that terrible day, and could not tell what had befallen him. At length, however, he became convalescent, and a good deal of his old vigour returned.

During this period of illness and convalescence Oliver had been constrained by old Mr. Donnithorne to take up his abode in his house, and the young doctor could not have experienced more attention and kindness from the old couple if he had been their son. Rose Ellis, too, did her best to cheer him, and, as we need scarcely add, was wonderfully successful in her efforts!

It was during this period that Oliver made the acquaintance of a young man of St. Just, named Charles Tregarthen—a congenial spirit—and one who was, besides, a thorough gentleman and an earnest Christian. With this youth he formed a sincere friendship, and although the subject of religion was never obtrusively thrust upon him by young Tregarthen, it entered so obviously into all his thoughts, and shone so clearly in his words and conduct, that Oliver's heart was touched, and he received impressions at that time which never left him.

Oliver and his friend were sitting one forenoon in Mr. Donnithorne's dining-room, which commanded an extensive view of green fields and grass-covered stone walls, with the beams and machinery of mines on the horizon, and the blue sea beyond. They were planning a short walking tour, which it was thought would be of great benefit to Oliver in that stage of his recovery, when old Mr. Donnithorne entered the room with a somewhat perturbed expression of countenance.

"How are you, Charlie my boy?" he said. "Oliver, I want to have a few minutes' talk with you in my room on business; I know Charlie will excuse you."

"I was on the point of taking leave at any rate," said Tregarthen, with a smile, as he grasped Oliver's hand; "think over our plan, like a good fellow, I am sure Mr. Donnithorne will approve of it, and I'll look in to-morrow forenoon to hear what decision you come to."

"Oliver," said Mr. Donnithorne, sitting down opposite the invalid, when his friend had left, and frowning portentously, "d' you know I'm a ruined man?"

"I trust not, uncle," replied Oliver, with an incredulous smile, supposing that the old gentleman was jesting.

"Yes, but I am," he repeated with tremendous gravity. "At all events, I shall be ere long. These—these—vile jewels will be the death of me."

Having thus broken the ice Mr. Donnithorne went on with much volubility of utterance and exasperation of tone to explain that legal proceedings had been instituted for the recovery of the jewels which he had purchased from the fishermen; that things seemed almost certain to go against him, and that in all probability he should be compelled to sell his estate in order to refund the money.

"But can you not sell your shares in Botallack and refund with the proceeds?" said Oliver.

"No, I cannot," replied the old gentleman. "You know that at present these shares are scarcely saleable except at a ruinous discount, and it would be a pity to part with them just now, seeing that there is some hope of improvement at this time. There is nothing for it but to sell my estate, and I don't think there will be enough left to buy butter to my bread after this unhappy affair is settled, for it amounts to some thousands of pounds."

"Indeed, uncle! how comes it that they found out the value of them?"

"Oh, simply enough, Oliver, but strangely too. You must know that Maggot, the scoundrel (and yet not such a scoundrel either, for the fellow informed on me in a passion, without having any idea of the severity of the consequences that would follow),—Maggot, it seems, kept the cloth belt in which the jewels were found tied round the owner's waist, and there happened to be a piece of parchment sewed up in the folds of it, in which the number and value of the jewels were enumerated. This belt was ferreted out by the lawyers, and the result is that, as I said before, I shall be a ruined man. Verily," added Mr. Donnithorne, with a look of vexation, as he stumped up and down the room with his hands thrust deep into his breeches-pockets, "verily, my wife was a true prophetess when she told me that my sin would be sure to find me out, and that honesty was the best policy. 'Pon my conscience, I'm half inclined to haul down my colours and let her manage me after all!"

"I am much concerned at what you tell me," said Oliver, "and I regret now very deeply that the few hundreds which I possessed when I came here—and which you know are all my fortune—have also been invested in Botallack shares, for they should have been heartily at your service, uncle."

"Don't trouble yourself about your hundreds, lad," said the old gentleman testily; "I didn't come here to ask assistance from you in that way, but to tell you the facts of the case, and ask you to do me the favour to carry a letter to my lawyer in Penzance, and inquire into the condition of a mine I have something to do with there—a somewhat singular mine, which I think will surprise as well as interest you; will you do this for me, lad?"

"Most willingly," replied Oliver. "You heard my friend Charlie Tregarthen speak of our intention to go on a walking tour for a couple of days; now, if you have no objection, he and I will set off together without delay, and make Penzance our goal, going round by the Land's End and the coast."

"So be it, Oliver, and don't hurry yourselves, for the business will wait well enough for a day or two. But take care of yourself, lad; don't go swimming off the Land's End again, and above all things avoid smugglers. The scoundrels! they have been the ruin of me, Oliver. Not bad fellows in their way either, but unprincipled characters—desperately regardless of the national laws; and—and—keep clear of 'em, I advise you strongly; have nothing to do with 'em, Oliver, my son."

So saying the old gentleman left the room, shaking his head with profound gravity.

CHAPTER XVIII.

TELLS OF KING ARTHUR AND OTHER MORE OR LESS FABULOUS MATTERS.

Next day Oliver Trembath and his friend Charles Tregarthen, before the sun had mounted his own height above the horizon, were on their way to the Land's End.

The young men were admirably suited to each other. Both were well educated, and possessed similar tastes, though their temperaments were dissimilar, and both were strong athletic youths,—Oliver's superiority in this latter respect being at that time counterbalanced by his recent illness, which reduced him nearly to a level with his less robust companion.

Their converse was general and desultory until they reached the Land's End, on the point of which they had resolved to breakfast.

"Now, Oliver, we have purchased an appetite," said Tregarthen, throwing down a wallet in which he carried some provisions; "let us to work."

"Stay, Charlie, not here," said Oliver; "let us get out on the point, where we shall have a better view of the cliffs on either side of the Land's End. I love a wide unobstructed view.

"As you will, Oliver; I leave you to select our table, but I pray you to remember that however steady your head may have been in days of yore when you scaled the Scottish mountains, the rough reception it has met with in our Cornish mines has given it a shake that renders caution necessary."

"Pshaw! Charlie, don't talk to me of caution, as if I were a timid old woman."

"Nay, then, I talk of it because you are *not* a timid old woman, but a reckless young man who seems bent on committing suicide. Yonder is a grassy spot which I think will suit you well."

He pointed to a level patch of sward on the neck of land that connects the outlying and rugged promontory which forms the extreme Land's End with the cliffs of the mainland. Here they spread their meal, and from this point they could see the cliffs and bays of the iron-bound shore extending on the one hand towards Cape Cornwall, and on the other towards that most romantic part of the coast known by the somewhat curious name of Tolpedenpenwith, where rocks and caverns are found in such fantastic fashion that the spot has become justly celebrated for picturesque grandeur. At their feet, far below, the great waves (caused by the swell, for there was no wind) boomed in solemn majesty, encircling the cliffs with lace-work of foam, while on the horizon the Scilly Islands could be seen shimmering faintly. A bright sun shone on the unruffled sea, and hundreds of ships and boats lay becalmed on its breast.

"'Tis a splendid scene!" said Oliver, sitting down beside his friend.

"It is indeed, and reminds me of the sea of glass before the great white throne that we read of in Revelation. It is difficult to imagine or to believe that the peaceful water before us, lying between this spot and the Scilly Islands yonder, was once a land full of verdure and life—yet such tradition tells us was the case.

"You mean, I suppose, the fabled land of Lyonesse?" said Oliver.

"Yes; you have heard the story of its destruction, I suppose?"

"Not I," said Oliver, "so if you have a mind to tell it me while I satisfy the cravings of an unusually sharp appetite I'll consider you a most obliging fellow. Pass me the knuckle of ham—thanks—and the bread—now go ahead."

"'Tis a romantic story," said Tregarthen.

"All the better," replied Oliver.

"And terrible," added Tregarthen.

"It won't spoil my appetite," said his friend.

"Well then, I'll tell it—to the best of my ability."

The youth then began the following legend, pausing ever and anon during the narration to swallow a piece of bread or a mouthful of cold tea, which constituted the principal elements of their frugal meal :—

"You must know that, once upon a time, long, long ago, in those ancient days before Norman or Dane had invaded this land, while Britain still belonged to the British, and King Arthur held his court in Tintagel's halls, there was a goodly land, named Lethowsow or the Lionesse, extending a distance of thirty miles between this cape and yonder shadowy islets which seem to float like cirrus clouds on the horizon. It is said that this land of Lionesse was rich and fertile, supporting many hundreds of families, with large flocks and herds. There were no fewer than forty churches upon it, from which it follows that there must have been a considerable population of well-doing people there.

"About the time of the events which I am going to narrate, King Arthur's reign was drawing to a close. Treason had thinned the ranks of the once united and famous knights of the Round Table. It is true that Sir Kaye, the seneschal, remained true, and Sir Ector de Maris, and Sir Caradoc, and Sir Tristram, and Sir Lancelot of the Lake, of whom it was said that 'he was the kindest man that ever struck with sword; and he was the goodliest person that ever rode among the throng of knights; and he was the meekest man, and the gentlest, that did ever eat in hall among ladies; and he was the sternest knight to his mortal foe that ever laid lance in rest.' But many seats at the Round Table that once were filled by brave warriors had become empty, and among these that of Prince Mordred, who, it was rumoured, meant to declare open war against his royal cousin and benefactor.

"One night King Arthur sat at the round table in Tintagel Castle with his knights gathered round him, and Queen Guenever with her maidens by his side. At the beginning of the feast the King's brow was clouded, for, although there was no lack of merriment or song, there was a want of the free-hearted courtesy and confidence of former days. Still the semblance of unabated good-fellowship was kept up, and the evening passed in gaiety until its close, when the King rose to retire. Taking in his hand a golden cup to pledge his guests, he was about to drink, when a shudder passed through his frame, and he cast the goblet away, exclaiming—'It is not wine, but blood! My father Merlin is among us, and there is evil in the coming days. Break we up our court, my peers! It is no time for feasting, but rather for fasting and for prayer.'

"The King glanced with a dark frown at the chair of his kinsman Mordred, but it was not empty! A strange, indistinct, shadowy form rested on it. It had no human shape, but a dreadful outline of something unearthly. Awe-struck and silent, the company at once broke up.

"On the following day, news of Mordred's revolt arrived at Tintagel Castle, and day after day fresh rumours reached it of foes flocking in numbers to the rebel standard. The army increased as it advanced, but, strange to say, King Arthur showed no disposition to sally forth and meet the traitor. It seemed as if his brave heart had quailed at last, and his good sword Excaliber had lost its magic virtue. Some thought that he doubted the fidelity of those who still remained around him. But, whatever the cause might have been, King Arthur made no preparation, and indicated no feeling or intention. He lay still in his castle until the rebels had approached to the very gates. There was something terrible in this mysterious silence of the King, which had a tendency to overawe the rebels as they drew near, and remembered that they were about to match themselves against warriors who had grown old in fellowship with Victory!

"When the main body of the invaders appeared, the great bell of the fortress at last rang out a stirring peal, and before the barbican the trumpets sounded to horse. King Arthur then with his knights and men at arms, the best warriors of Britain, arose and sallied forth to fight in their last battle.

"Next evening a broken band of horsemen alone remained to tell of the death of their King and the destruction of all their hopes. They numbered several hundreds, but their hacked armour, jaded steeds, and gaping wounds told that they were unfit to offer battle to any foe. They were in full flight, bearing a torn banner, still wet with the blood of King Arthur—yet they fled unwillingly, as men who were unused to retreat, and scarce knew how to comport them in the novel circumstances. Their course was in the direction of the Lionesse, the tract of country called in the Cornish tongue Lethowsow. On they dashed, without uttering a word, over the bleak moors before them. Sometimes they halted to drink at a spring or tighten their girths, and occasionally a man fell behind from sheer exhaustion. At night they encamped, after a hard ride of thirty miles. Next morning the flight was resumed, but the vindictive Mordred still thundered on in pursuit. Ere long they heard a trumpet sounding in their rear, and King Arthur's men halted for a few minutes, with the half-formed design of facing the foe and selling their lives dearly. While they paused in gloomy irresolution, gazing sternly on the advancing host, whose arms flashed back the rays of the morning sun, a mist rose up between them and their foes. It was a strange shadowy mist, without distinct form, yet not without resemblance to something ghostly. The knights at once recognised it as the shade of Merlin, the Great Wizard! Slowly the cloud uprose between the pursuers and pursued, effectually protecting the latter; nevertheless, although baffled, the former did not give up the chase.

"At last Mordred reached a lofty slope, from the top of which he descried his enemies retreating across the land of Lionesse. Mad with rage, he descended to the plain where soft sunlight shone through luxuriant glades and across the green pastures, gladdening the hearts of man and beast. Nature was all peaceful, and gloriously beautiful, but Mordred's eyes saw it not, his heart felt not the sweet influences. The bitterness induced by hatred and an evil conscience reigned within, as he urged his steed furiously onward.

"Suddenly a terrible change occurred in the atmosphere, which became oppressively sultry and horrible, while low muttering thunders were heard, and heavings of the earth felt. At the same time the cloud gradually condensed in front of Mordred, and, assuming a distinct form, stood before him in the person of Merlin the Wizard. For a few seconds they stood face to face, frowning on each other in awful silence. Then Merlin raised his arm, and immediately the thunders and confused mutterings increased, until the earth began to undulate and rend as if the foundations of the world were destroyed. Great fissures appeared, and the rocks welled up like the waves of the sea. With a cry of agony, the pursuers turned to fly. But it was too late. Already the earth was rent into fragments; it upheaved convulsively for a few seconds; then sank beneath the level of the deep, and the ocean rushed wildly over the land, leaving nothing behind to mark the spot where land had been, save the peaked and barren rocks you see before you, with the surge beating continually round them."

"A most extraordinary tale, truly," said Oliver. "Do you believe it has any foundation?"

"I believe not the supernatural parts of it, of course," replied Tregarthen; "but there is *something* in the fact that the land of Cornwall has unquestionably given up part of its soil to the sea. You are aware, I suppose, that St. Michael's Mount, the most beautiful and prominent object in Mounts Bay, has been described as 'a hoare rock in a wood,' about six miles from the sea, although it now stands in the bay; and this idea of a sunken land is borne out by the unquestionable fact that if we dig down a few feet into the sand of the shore near Penzance, we shall come on a black vegetable mould, full of woodland *detritus*, such as branches, leaves of coppice-wood and nuts, together with carbonized roots and trunks of forest trees of larger growth; and these have been found as far out as the lowest tide would permit men to dig! In addition to this, portions of land have been overwhelmed by the sea near Penzance, in the memory of men now alive."

"Hum!" said Oliver, stretching out his huge limbs like a giant basking in the sunshine, "I dare say you are correct in your suppositions, but I do not profess to be an antiquary, so that I won't dispute the subject with you; at the same time, I may observe, that it does seem to me as if there were a screw loose somewhere in the historical part of your narrative, for methinks I have read, heard, or dreamt, that King Arthur was Mordred's uncle, not his cousin, and that Mordred was slain, and that the King was the victor at the fatal field of Camelford, although the victory was purchased dearly—Arthur having been mortally wounded and carried back to Tintagel to die there. But, of course, I won't pretend to doubt the truth of your narrative because of such trifling discrepancies. As to the encroachment of the sea on the Cornish coast, and the evidences thereof in Mounts Bay, I raise no objection thereto, but I cannot help thinking that we want stronger proof of the existence of the land of Lionesse."

"Why, Oliver," said Tregarthen, laughing, "you began by saying that you would not dispute the subject with me, and in two minutes you have said enough to have justified a regular attack on my part, had I been so disposed. However, we have a long road before us, so I must protest against a passage of arms just now."

Having finished breakfast, the two friends proceeded along the coast a few miles to Tolpedenpenwith. Here, in the midst of the finest scenery on the coast, they spent the greater part of the day, and then proceeded to Penberth Cove, intending to secure a lodging for the night, order supper, and, while that was in preparation, pay a visit to the famous Logan Rock.

Penberth Cove is one of the prettiest little vales in the west of Cornwall. It is enriched with groups of trees and picturesque cottages, and possesses a luxuriant growth of shrubs and underwood, that almost conceals from view the streamlet, which is the chief cause of its fertility.

There were also, at the time we write of, one or two houses which, although not public inns, were open for the entertainment of travellers in a semi-private fashion. Here, therefore, our excursionists determined to put up for the night, with the widow of a fisherman who had perished in a storm while engaged in the herring fishery off the Irish coast.

This good woman's chief physical characteristic was rotundity, and her prominent mental attribute good-humour. She at once received the gentlemen hospitably, and promised to prepare supper for them while they went to visit the far-famed Logan or Logging Rock, which lay in the vicinity.

This rock is one of those freaks of nature which furnish food for antiquaries, points of interest to strangers, and occupation to guides. Every one who goes to the Land's End must needs visit the "Logan Rock," if he would "do" the country properly; and if our book were a "Guide to Cornwall," we should feel bound to describe it with much particularity, referring to its size, form, weight, and rocking quality, besides enlarging on the memorable incident in its career, when a wild officer of the navy displaced it from its pivot by means of seamen and crowbars, and was thereafter ordered to replace it (a herculean task, which he accomplished at great cost) on pain of we know not what penalties. But, as we make no pretensions to the important office of a guide, we pass this lion by, with the remark that Oliver and his friend visited it and rocked it, and then went back to Penberth Cove to sup on pilchards, after which followed a chat, then bed, sound sleep, daybreak and breakfast, and, finally, the road to Penzance, with bright sunshine, light hearts, and the music of a hundred larks ringing in the sky.

CHAPTER XIX.

SMALL TALK AND SOME ACCOUNT OF CORNISH FAIRIES.

"WHAT a splendid country for a painter of cliffs!" observed Oliver, as the friends walked briskly along; "I wonder much that our artists do not visit it more frequently."

"Perhaps they find metal more attractive nearer home," replied Tregarthen; "all the world has not fallen so violently in love with furze-clad moorland and rugged sea-cliffs as you seem to have done. Besides, the country is somewhat remote. Mayhap when a railway runs into it, which will doubtless be the case before many years pass by, we shall see knights of the brush pitching their white tents on the Land's End—meanwhile we have a few promising young men of our own who bid fair to rival the great Opie himself. You have heard of him, of course?"

"I have heard of him indeed, and seen some of his works, but I'm ashamed to confess that, having left Cornwall when very young, and been a dweller in the far north of the kingdom ever since, I have only known the facts that he was a celebrated Cornish artist, and became the President of the Royal Academy. Can you tell me anything of his personal history?"

"Not much, but I can give you a brief outline of his career. John Opie was the son of a carpenter of St. Agnes, near Truro, and was discovered and extracted, like a 'bunch' of rich ore, from the midst of the tin mines, by Dr. Wolcot—who was celebrated under the name of Peter Pindar. The doctor first observed and appreciated Opie's talent, and, resolving to bring him into notice, wrote about him, until he became celebrated as the 'Cornish Wonder.' He also introduced people of note to the artist's studio in London, many of whom sat for their portraits. These gave so much satisfaction that the reputation of the 'Cornish Wonder' spread far and wide, and orders came pouring in upon him, insomuch that he became a rich man and a Royal Academician, and ultimately President of the Academy. He married an authoress, and his remains were deposited in St. Paul's Cathedral, near to those of Sir Joshua Reynolds. I have heard my grandfather say that he met him once in the town of Helston, and he described him as somewhat rough and unpolished, but a sterling, kind-hearted man."

"Did he paint landscape at all?" inquired Oliver.

"Not much, I believe. He devoted himself chiefly to portraits."

"Well, now," said Oliver, looking round him, "it strikes me that this is just the country for a landscape-painter. There is nowhere else such fine cliff scenery, and the wild moors, which remind me much of Scotland, are worthy of being sketched by an able brush."

"People have curiously different opinions in reference to the moors which you admire so much," said Tregarthen. "A clergyman who lived and wrote not very long ago, came to Cornwall in search of the picturesque, and he was so disappointed with what he termed a barren desolate region, that he stopped suddenly on the road between Launceston and Bodmin, and turned his back on Cornwall for ever. As might be expected, such a man gave a very false idea of the country. On the other hand, a more recent writer, commenting on the first, speaks of his delight,—after having grown somewhat tired of the almost too rich and over-cultivated scenery of Kent,—on coming to what he styled 'a sombre apparition of the desert in a corner of green England,' and dwells with enthusiasm on 'these solitudes, and hills crowned with rugged rocks, classical heaths and savage ravines, possessing a character of desolate grandeur.' But this writer did more. He travelled through the country, and discovered that it possessed other and not less beautiful features; that there were richly clothed vales and beautiful rivulets, cultivated fields and prolific gardens, in close proximity to our grand cliffs and moors."

"He might have added," said Oliver, "that plants and flowers flourish in the open air here, and attain to a size and luxuriance which are rare in other parts of England. Why, I have seen myrtles, laurels, fuchsias, pomegranates, and hortensias forming hedges and growing on the windows and walls of many houses. To my mind Cornwall is one of the finest counties in England—of which Flora herself has reason to be proud, and in which fairies as well as giants might dwell with much delight."

"Spoken like a true Cornishman!" said Tregarthen, laughing; "and in regard to the fairies I may tell you that we are not without a few of them, although giants confessedly preponderate."

"Indeed!" said Oliver; "pray whereabouts do they dwell?"

"You have heard of the Gump, I suppose?"

"What! the barren plain near Carn Kenidjack, to the north of St. Just?"

"The same. Well, this is said to be a celebrated haunt of the pixies, who have often led benighted travellers astray, and shown them wonderful sights. Of course one never meets with any individual who has actually seen them, but I have frequently met with those who have assured me they had known others who had conversed with persons who had seen fairies. One old man, in particular, I have heard of, who was quite convinced of the reality of a fairy-scene which he once witnessed.

"This old fellow was crossing the Gump one evening, by one of the numerous paths which intersect it. It was summer-time. The sun had gone down beyond the sea-line, and the golden mists of evening were merging into the quiet grey that hung over the Atlantic. Not a breath of wind passed over land or sea. To the northward Chun Castle stood darkly on the summit of the neighbouring hill, and the cromlech loomed huge and mysterious; southward were traces of mystic circles and upright stones, and other of those inexplicable pieces of antiquity which are usually saddled on the overladen shoulders of the Druids. Everything, in fact—in the scene, the season, and the weather,—contributed to fill the mind of the old man with romantic musings as he wended his way over the barren moor. Suddenly there arose on the air a sound of sweet, soft music, like the gentle breathings of an Æolian harp. He stopped and gazed around with looks of mingled curiosity and surprise, but could see nothing unusual. The mysterious sounds continued, and a feeling of alarm stole over him, for twilight was deepening, and home was still far distant. He attempted to advance, but the music had such a charm for him that he could not quit the spot, so he turned aside to discover, if possible, whence it came. Presently he came to a spot where the turf was smoother and greener than elsewhere, and here the most wonderful and enchanting scene met his gaze. Fairies innumerable were before him; real live fairies, and no mistake. Lying down on the grass, the old man crept cautiously towards them, and watched their proceedings with deep interest. They were evidently engaged in the pleasant occupation of holding a fair. There were stalls, tastefully laid out and decorated with garlands of flowers. On these were spread most temptingly all the little articles of fairy costume. To be sure the said costume was very scanty, and to all appearance more picturesque than useful; nevertheless there was great variety. Some wore heath-bells jauntily stuck on their heads; some were helmeted with golden blossoms of the furze, and looked warlike; others had nothing but their own luxuriant hair to cover them. A few of the lady-fairies struck the old man as being remarkably beautiful, and one of these, who wore an inverted tulip for a skirt, with a small forget-me-not in her golden hair, seemed to him the very picture of what his old Molly had been fifty years before. It was particularly noticeable that the stalls were chiefly patronized by the fairy fair-sex, with the exception of one or two which were much frequented by the men. At these latter, articles were sold which marvellously resembled cigars and brandy, and the old man declared that he saw them smoke the former, and that he smelt the latter; but as he had himself been indulging a little that evening in smuggled spirits and tobacco, we must regard this as a somewhat ungenerous statement on his part, for it is ridiculous to suppose that fairies could be such senseless creatures as to smoke or drink! They danced and sang, however, and it was observed that one young man, with a yellow nightcap and a bad cold, was particularly conspicuous for his anxiety to be permitted to sing.

"The music was naturally the great attraction of the evening. It consisted of a large band, and although some of the performers used instruments made of reeds, and straws, and other hollow substances, cut into various forms and lengths, most of them had noses which served the purpose of musical instruments admirably. Indeed, the leader of the band had a prolongation of the nose so like to a flesh-coloured clarionet, that it might easily have been mistaken for the real thing, and on this he discoursed the most seraphic music. Another fairy beside him had a much longer nose, which he used as a trombone with great effect. This fellow was quite a character, and played with such tremendous energy that, on more than one occasion, he brought on a fit of sneezing, which of course interrupted the music, and put the clarionet in a passion. A stout old mis-shapen gnome, or some such creature, with an enormous head, served for the big drum. Four fairies held him down, and a fifth belaboured his head with a drum-stick. It sounded wonderfully hollow, and convinced the old man that it was destitute of brains, and not subject to headache.

"All the time that the old man gazed at them, troops of fairies continued to arrive, some on the backs of bats, from which they slipped as they whirred past; others descending, apparently, on moonbeams. The old man even fancied that he saw one attempting to descend by a starbeam, which, being apparently too weak to support his weight, broke, and let him down with a crash into the midst of a party who were very busy round a refreshment stall, where a liberal supply of mountain dew was being served out; but the old man never felt quite sure upon this point, for, at sight of the mountain-dew, he felt so thirsty that he determined to taste it. Fixing his eyes on the stall, he suddenly threw his hat into the midst of the party, and made a dash at it; but, to his intense disappointment, the vision was instantly dispelled, and nothing was to be seen on the spot but a few snails creeping over the wet grass, and gossamer threads bespangled with dew-drops."

"A very pretty little vision," exclaimed Oliver, "and not the first that has been prematurely dispelled by too ardent a pursuit of strong drink! And now, Charlie, as you appear to be in the vein, and we have still some distance to go, will you tell me something about the giants, and how it came to pass that they were so fond of roaming about Cornwall?"

"Their fondness for it, Oliver, must be ascribed to the same cause as your own—just because it is a loveable place," said Tregarthen; "moreover, being a thinly-peopled county, they were probably not much disturbed in their enjoyment of it. To recount their surprising deeds would require a longer space of time than is just now at our disposal, but you have only to look around, in passing through the country, to understand what a mighty race of men they were. There are 'giants' quoits,' as you know, without end, some of which have the marks of the fingers and thumbs with which they grasped them. Their strength may be estimated by the fact that one of these quoits is no less than forty feet long, and twenty wide, and weighs some hundreds of tons. It would puzzle even your strong arm to toss such a quoit! One of these giants was a very notable fellow. He was named 'Wrath,' and is said to have been in the habit of quenching his thirst at the Holy Well under St. Agnes's Beacon, where the marks of his hands, made in the solid granite while he stooped to drink, may still be seen. This rascal, who was well named, is said to have compelled poor St. Agnes, in revenge for her refusing to listen to his addresses, to carry in her apron to the top of Beacon Hill, the pile of stones which lie there. But here we are at Penzance, so we shall have done with fiction for the present, and revert to matters of fact. You have business with a lawyer, I believe, and I have business for a short time with a friend. Let us appoint a time and place of meeting."

"What say you to the Wherry Mine at two o'clock?" said Oliver. "It is probable that my business will be concluded by that time, when we can go see this mine together. My uncle seems to set great store by it, because of an old prophecy to the effect that some day or other it will enrich somebody!"

"Why, that prophecy has been fulfilled long ago," said Tregarthen, with a laugh. "The mine was a bold undertaking, and at one time paid well, but I fear it won't do so again. However, let us meet there; so farewell, old boy, till two."

CHAPTER XX.

THE MINE IN THE SEA.

TRUE to their appointment, young Tregarthen and Oliver Trembath met at the western end of the town of Penzance, close to the sea-beach, where a mass of buildings and a chimney indicated the position of the Wherry Mine.

Oliver's countenance betrayed anxiety as he came forward.

"Nothing wrong, I hope?" said Tregarthen.

"Well, I can't say exactly that things are wrong; but, at the same time, I don't know that they are altogether right."

"Much the same thing," said Tregarthen, smiling; "come, Oliver, unbosom yourself, as novelists say. It will do you good, and two heads, you know, are better than one."

"It's not easy to unbosom myself, old fellow," returned Oliver, with a troubled look; "for my poor uncle's affairs are in a perplexed condition, and I hate explanations, especially when I don't understand the nature of what I attempt to explain, so we'll not talk about it, please, till after our visit to the mine. Let it suffice to say that that notorious smuggler Jim Cuttance is concerned in it and that we must go to Newlyn this afternoon on a piece of business which I shall afterwards disclose. Meanwhile, where is this mine?"

"Lift up your eyes and behold," said Tregarthen, pointing to an object which was surrounded by the sea, and stood above two hundred yards from the beach.

"What! that martello-tower-like object?" exclaimed Oliver in much surprise.

"Even so," replied Tregarthen, who thereupon proceeded to give his friend a history and description of the mine—of which the following is the substance:—

At the western extremity of the sea-beach at Penzance there is a reef of sunken rocks which shows its black crest above water at low tide. It was discovered that this reef contained tin, and the people of the town attacked it with hammers and chisels, when each receding tide left it exposed, as long as the seasons would permit, until the depth became unmanageable. After having been excavated a few fathoms the work was abandoned.

Fortunately for the progress of this world there exist a few enterprising men whom nothing can discourage, who seem to be spurred on by opposition, and to gather additional vigour and resolution from increasing difficulties. These men are not numerous, but the world is seldom without a few of them—and one made his appearance in Penzance about the end of last century, in the person of a poor miner named Thomas Curtis. This man conceived the bold design of sinking a shaft through this water-covered rock, and thus creating a mine not only *under*, but *in* the sea.

With the energy peculiar to his class he set to work. The distance of the rock from the beach was about two hundred and forty yards; the depth of water above it at spring-tides about nineteen feet. Being exposed to the open sea, a considerable surf is raised on it at times by the prevailing winds, even in summer; while in winter the sea bursts over with such force as to render all operations on it impossible.

That Curtis was a man of no common force of character is obvious from the fact that, apart from the difficulties of the undertaking, he could not expect to derive any profit whatever from his labour for several years. As the work could only be carried on during the short period of time in which the rock was above water, and part of this brief period must necessarily be consumed each tide in pumping out the water in the excavation, it of course progressed slowly. Three summers were consumed in sinking the pump-shaft. After this a framework, or caissòn, of stout timber and boards, was built round the mouth of the shaft, and rendered watertight with pitch and oakum. It rose to a height of about twelve feet above the surface of the sea, and was strengthened and supported by stout bars, or buttresses of timber. A platform was placed on the top, and a windlass, at which four men could work, was fixed thereon. This erection was connected with the shore by a stage or "wherry" erected on piles. The water was cleared out; the men went "underground," and, with the sea rolling over their heads, and lashing wildly round the turret which was their only safeguard from terrible and instant destruction, they hewed daily from the submarine rock a considerable portion of tin.

These first workers, however, had committed an error in carrying on their operations too near the surface, so that water permeated freely through the rock, and the risk of the pressure above being too great for it rendered the introduction of immense supporting timbers necessary. The water, too, forced its way through the shaft during the winter months, so that the regular working of the mine could not be carried on except in summer; nevertheless, this short interval was sufficient to enable the projector to raise so much ore that his mine got the reputation of being a profitable adventure, and it was wrought successfully for many years.

About the end of the century the depth of the pump-shaft was above four fathoms, and the roof had been cut away to the thinness of three feet in some places. Twelve men were employed for two hours at the windlass in hauling the water, while six others were "teaming" from the bottom into the pump. When sufficient water had been cleared away the men laboured at the rock for six hours—in all, eight hours at a time. The prolific nature of the mine may be gathered from the fact that in the space of six months ten men, working about one-tenth of that time—less than three weeks—broke about £600 worth of ore. During one summer £3000 worth of tin was raised!

A steam-engine was ultimately attached to the works, and the mine was sunk to a depth of sixteen fathoms, but the expense of working it at length became so great that it was abandoned—not, however, before ore to the amount of £70,000 had been raised from under the sea!

At the time of our tale another effort had been made to work the Wherry Mine, and great expectations had been raised, but these expectations were being disappointed. Our unfortunate friend Mr. Donnithorne was among the number of those who had cause to regret having ventured to invest in the undertaking, and it was to make inquiries in regard to certain unfavourable rumours touching the mine that Oliver Trembath had been sent to Penzance.

After inspecting Wherry Mine the two friends walked along the shore together, and Oliver explained the nature of the difficulties in which his uncle was involved.

"The fact is, Charlie," he said, "an old fish-purchaser of Newlyn named Hitchin is one of the principal shareholders in this concern; he is as rich, they say, as Crœsus, and if we could only prevail on him to be amiable the thing might be carried on for some time longer with every hope of a favourable result, for there can be no doubt whatever that there is plenty of tin in the mine yet, and the getting of it out is only a question of time and capital."

"A pretty serious question—as most speculators find," said Tregarthen, laughing; "you appear to think lightly of it."

"Well, I don't pretend to know much about such matters," replied Oliver, "but whatever may be the truth of the case, old Hitchin refuses to come forward; he says that he is low in funds just now, which nobody seems to believe, and that he owes an immense sum of money to Jim Cuttance the smuggler, for what, of course, he will not tell, but we can have no difficulty in guessing. He says that Cuttance is pressing him just now, and that, therefore, he cannot afford to advance anything on the mine. This being the case it must go down, and, if it does, one of the last few gleams of prosperity that remain to my poor uncle will have fluttered away. This must be prevented, if possible, and it is with that end in view that I purpose going to Newlyn this afternoon to see Hitchin and bring my persuasive powers to bear on him."

"H'm, not of much use, I fear," said Tregarthen. "Hitchin is a tough old rascal, with a hard heart, and a miserly disposition. However, it may be worth while to make the attempt, for you have a very oily tongue, Oliver."

"And you have an extremely impudent one, Charlie. But can you tell me at what time the mackerel boats may be expected this evening, for it seems the old fellow is not often to be found at home during the day, and we shall be pretty sure to find him on the beach when the boats arrive?"

Thus appealed to, Tregarthen cast a long look at the sea and sky.

"Well, I should say, considering the state of the tide and the threatening appearance of the sky, we may expect to see them at six o'clock, or thereabouts."

"That leaves us nearly a couple of hours to spare; how shall we spend it?" said Oliver.

"Go and have a look at this fine old town," suggested Tregarthen. "It is worth going over, I assure you. Besides the town-hall, market, museum, etc., there are, from many points of the surrounding eminences, most superb views of the town and bay with our noble St. Michael's Mount. The view from some of the heights has been said by some visitors to equal the far-famed Bay of Naples itself."

"Part of this I have already seen," said Oliver, "the rest I hope to live to see, but in the meantime tin is uppermost in my mind; so if you have no objection I should like to have a look at the tin-smelting works. What say you?"

"Agreed, by all means," cried Tregarthen; "poor indeed would be the spirit of the Cornishman who did not feel an interest in tin!"

CHAPTER XXI.

TREATS OF TIN-SMELTING AND OTHER MATTERS.

THERE is something grand in the progress of a mechanical process, from its commencement to its termination. Especially is this the case in the production of metals, nearly every step in the course of which is marked by the hard, unyielding spirit of *vis inertiæ* on the one hand, and the tremendous power of intelligence, machinery, and manual dexterity on the other.

Take, for example, the progress of a mass of tin from Botallack.

Watch yonder stalwart miner at work, deep in the bowels of the mine. Slowly, with powerful blows, he bores a hole in the hard rock. After one, two, or three hours of incessant toil, it is ready for the powder. It is charged; the match is applied; the man takes shelter behind a projection; the mass is rent from its ancient bed, and the miner goes off to lunch while the smoke is clearing away. He returns to his work at length, coughing and rubbing his eyes, for smoke still lingers there, unable, it would seem, to find its way out; and no wonder, lost as it is in intricate ramifications at the depth of about one thousand five hundred feet below the green grass! He finds but a small piece of ore—perhaps it is twice the size of his head, it may be much larger, but, in any case, it is an apparently poor return for the labour expended. He adds it, however, to the pile at his side, and when that is sufficiently large fills a little iron waggon, and sends it up "to grass" through the shaft, by means of the iron "kibble." Here the large pieces of ore are broken into smaller ones by a man with a hammer; as far as the inexperienced eye can distinguish he might be breaking ordinary stones to repair the road! These are then taken to the "stamps."

Those who have delicate nerves would do well to keep as far as possible from the stamps of a tin mine! Enormous hammers or pounders they are, with shanks as well as heads of malleable iron, each weighing, shank and head together, seven cwt. They are fearful things these stamps; iron in spirit as well as in body, for they go on for ever—night and day—wrought by a steam-engine of one hundred horse-power, as enduring as themselves. The stamps are so arranged as to be self-feeders, by means of huge wooden troughs with sloping bottoms, into which the ore is thrown in quantities sufficient to keep them constantly at work without requiring much or constant attendance. Small streams of water trickle over the ore to keep it slowly sliding down towards the jaws, where the stamps thunder up and down alternately. A dread power of pounding have they, truly; and woe be to the toe that shall chance to get beneath them!

The rock they have to deal with is, as we have said, uncommonly hard, and it enters the insatiable mouth of the stamps about the size of a man's fist, on the average, but it comes out from these iron jaws so exceeding fine as to be incapable of thickening the stream of reddish-yellow water that carries it away. The colour of the stream is the result of iron, with which the tin is mingled.

The particles of tin are indeed set free by the stamps from solid bondage, but they are so fine as to be scarcely visible, and so co-mingled with other substances, such as iron, copper, sulphur, etc., that a tedious process of separation has yet to be undergone before the bright metal can be seen or handled.

At the present time the stream containing it is poured continuously on several huge wooden tables. These tables are each slightly raised in the centre where the stream falls, so that all the water runs off, leaving the various substances it contains deposited on the table, and these substances are spread over it regularly, while being deposited, by revolving washers or brushes.

Tin, being the heaviest of all the ingredients contained in the stream, falls at once to the bottom, and is therefore deposited on the head or centre of the table; iron, being a shade lighter, is found to lodge in a circle beyond, while all other substances are either spread over the outer rim or washed entirely away. When the tables are full,—that is, coated with what appears to be an earthy substance upwards of a foot in depth, the rich tin in the centre is carefully cut out with shovels and placed in tubs, while the rest is rewashed in order that the tin still mingled with it may be captured—a process involving much difficulty, for tin is so very little heavier than iron that the lighter particles can scarcely be separated even after repeated and careful washings.

In old times the tin was collected in large pits, whence it was transferred to the hands of bal-maidens (or mine-girls) to be washed by them in wooden troughs called "frames," which somewhat resembled a billiard-table in form. Indeed, the frames are still largely employed in the mines, but these and the modern table perform exactly the same office—they wash the refuse from the tin.

Being finally cleansed from all its impurities, our mass of tin bears more resemblance to brown snuff than to metal. An ignorant man would suppose it to be an ordinary earthy substance, until he took some of it in his hand and felt its weight. It contains, however, comparatively little foreign substance. About seventy per cent. of it is pure tin, but this seventy per cent. is still locked up in the tight embrace of thirty per cent. of refuse, from which nothing but intense fire can set it free.

At this point in the process, our mass of tin leaves the rough hand of the miner. In former days it was divided among the shareholders in this form—each receiving, instead of cash, so many sacks of tin ore, according to the number of his shares or "doles," and carrying it off on mule or horse back from the mine, to be smelted where or by whom he pleased. But whether treated in this way, or, as in the present day, sold by the manager at the market value, it all comes at last to the tin-smelter, whose further proceedings we shall now follow, in company with Oliver and his friend.

The agent of the smelting company—a stout, intelligent man, who evidently did "knaw tin"—conducted them first to the furnaces, in the neighbourhood of which were ranged a number of large wooden troughs or bins, all more or less filled with tin ore. The ore got from different mines, he said, differed in quality, as well as in the percentage of tin which it contained. Some had much iron mixed with it, in spite of all the washings it had undergone; some had a little copper and other substances;

while some was very pure. By mixing the tin of different mines, better metal could be procured than by simply smelting the produce of each mine separately. Pointing to one of the bins, about three yards square, he told them it contained tin worth £1000. There was a large quantity of black sand in one of the bins, which, the agent said, was got by the process of "streaming." It is the richest and best kind of tin ore, and used to be procured in large quantities in Cornwall,—especially in ancient times,—being found near the surface, but, as a matter of course, not much of that is to be found now, the land having been turned over three times in search of it. This black sand is now imported in large quantities from Singapore.

The agent then conducted his visitors to the testing-house, where he showed them the process of testing the various qualities of tin ore offered to the House for sale. First he weighed out twenty parts of the ore, which, as we have said, resembled snuff. This, he remarked, contained about five-sixths of pure tin, the remaining one-sixth being dross. He mixed it with four parts of fine coal-dust, or culm, and added a little borax—these last ingredients being intended to expedite the smelting process. This compound was put into a crucible, and subjected to the intense heat of a small furnace for about twenty minutes. At the end of that time, the agent seized the crucible with a pair of tongs, poured the metal into an iron mould, and threw away the dross. The little mass of tin thus produced was about four inches long, by half an inch broad, and of a dull bluish-grey colour. It was then put into an iron ladle and melted, as one would melt lead when about to cast bullets, but it was particularly noteworthy here, that a very slight heat was required. To extract the metal from the tin ore, a fierce heat, long applied, was necessary, but a slight heat, continued for a few minutes, sufficed to melt the metal. This re-melted metal was poured into a stone mould, where it lay like a bright little pool of liquid silver. In a few seconds it solidified, retaining its clear purity in all its parts.

"That," said the agent, "is tin of the very best quality. We sell it chiefly to dyers, who use it for colouring purposes, and for whom no tin but the best is of any use. I will now show you two other qualities—namely, second and inferior.

He went to a small cupboard as he spoke, and extracted therefrom a small piece of tin which had already gone through the smelting process in the crucible above described. Melting this in the ladle, he poured it into the mould, where it lay for a few moments quite bright and pure, but the instant it solidified, a slight dimness clouded its centre.

"That," explained the agent, "is caused by a little copper which they have failed to extract from the tin. Such tin would not do for the dyers, but it is good for the tin-plate makers, who, by dipping thin sheets of iron into molten tin, produce the well-known tin-plates of which our pot-lids and pans, etc., are manufactured. This last bit, gentlemen," he added, taking a third piece of tin from the cupboard, "is our worst quality."

Having melted it, he poured it into the mould, where it assumed a dull, half-solid appearance, as if it were a liquid only half frozen—or, if you prefer it, a solid in a half molten state.

"This is only fit to mix with copper and make brass," said the agent, throwing down the mould. "We test the tin ore twice—once to find out the quantity of metal it contains, and again to ascertain its quality. The latter process you have seen—the former is just the same, with this difference, that I am much more careful in weighing, measuring, etc. Every particle of dross I would have collected and carefully separated from any metal it might contain; the whole should then have been re-weighed, and its reduction in the smelting process ascertained. Thus, if twenty parts had been the weight of tin ore, the result might perhaps have been fourteen parts of metal and six parts of dross.—And now, gentlemen, having explained to you the testing process, if you will follow me, I will show you the opening of one of our furnaces. The smelting-furnace just shows the testing process on a large scale. Into this furnace, six hours ago," he said, pointing to a brick erection in the building to which he led them, "we threw a large quantity of tin ore, mingled with a certain proportion of culm. It is smelted and ready to be run off now."

Here he gave an order to a sturdy man, who, with brawny arms bared to the shoulders, stood close at hand. He was begrimed and hairy—like a very Vulcan.

Seizing an iron poker, Vulcan probed the orifice of the furnace, and forthwith there ran out a stream of liquid fire, which was caught in an iron bowl nearly four feet in diameter. The intense heat of this pool caused the visitors to step back a few paces, and the ruddy glow shone with a fierce glare on the swart, frowning countenance of Vulcan, who appeared to take a stern delight in braving it.

Oliver's attention was at once attracted to this man, for he felt convinced that he had seen his face before, but it was not until he had taxed his memory for several minutes, that the scene of his adventure with the smugglers near the Land's End flashed upon him, when he at once recognised him as the man named Joe Tonkin, who had threatened his life in the cavern. From a peculiar look that the man gave him, he saw that he also was recognised.

Oliver took no further notice of him at the time, however, but turned to watch the flow of the molten tin.

When the iron cauldron was almost full, "slag," or molten refuse, began to flow and cover the top of the metal. The hole was immediately plugged up by Vulcan, and the furnace cleared out for the reception of another supply of ore. The surface of the tin was now cleared of slag, after which it was ladled into moulds and allowed to cool. This was the first process completed; but the tin was still full of impurities, and had to undergo another melting and stirring in a huge cauldron. This latter was a severe and protracted operation, which Vulcan performed with tremendous power and energy.

In reference to this, it may interest the reader to mention a valuable discovery which was the result of laziness! A man who was employed in a tin-smelting establishment, at this laborious work of stirring the molten metal in order to purify it, accidentally discovered that a piece of green wood dropped into it had the effect of causing it to bubble as if it were boiling. To ease himself of some of his toil, he availed himself of the discovery, and, by stirring the metal with a piece of green wood, caused such a commotion that the end in view was accomplished much more effectually and speedily than by the old process. The lazy man's plan, we need scarcely add, is now universally adopted.

The last operation was to run the metal into moulds with the smelter's name on them, and these ingots, being of portable size, were ready for sale.

While the agent was busily engaged in explaining to Charles Tregarthen some portions of the work, Oliver stepped aside and accosted Joe Tonkin.

"So, friend," he said, with a smile, "it seems that smuggling is not your only business?"

"No sur, it ain't," replied Joe, with a grin. "I'm a jack-of-all-trades—a smelter as you do see, an' a miner also, when it suits me."

"I'm glad to hear it, my man, for it gives you a chance of coming in contact with better men than smugglers—although I'm free to confess that there *is* some good among them too. I don't forget that your comrade Jim Cuttance hauled me out of the sea. Where is he?"

"Don't knaw, sur," replied Tonkin, with an angry frown; "he and I don't pull well together. We've parted now."

Oliver glanced at the man, and as he observed his stern, proud expression of face, and his huge powerful frame, he came to the conclusion that Cuttance had met a man of equal power and force of character with himself, and was glad to get rid of him.

"But I have not gi'n up smuggling," added the man, with a smile. "It do pay pretty well, and is more hearty-like than this sort o' thing."

"I'd advise you to fall back on mining," said Oliver. "It is hard work, I know, but it is honest labour, and, as far as I have seen, there does not appear to be a more free, hearty, and independent race under the sun than Cornish miners."

Joe Tonkin shook his head and smiled dubiously.

"You do think so, sur, but you haven't tried it. I don't like it. It don't suit me, it don't. No, no; there's nothin' like a good boat and the open sea."

"Things are looking a little better at Botallack just now, Joe," said Oliver, after a pause. "I'd strongly advise you to try it again."

The man remained silent for a few minutes, then he said—

"Well, Mr. Trembath, I don't mind if I do. I'm tired o' this work, and as my time is up this very day, I'll go over to-morrow and see 'bout it. There's a man at Newlyn as I've got somethin' to say to, I'll go see him to-night, and then—."

"Come along, Oliver," shouted Tregarthen at that moment; "it's time to go."

Oliver bade Tonkin good afternoon, and, turning hastily away, followed his friend.

The two proceeded arm-in-arm up Market-Jew Street, and turning down towards to the shore, walked briskly along in the direction of the picturesque fishing village of Newlyn, which lies little more than a mile to the westward of Penzance.

CHAPTER XXII.

SHOWS HOW OLIVER AND HIS FRIEND WENT TO NEWLYN AND SAW THE MACKEREL MARKET, AND FOUND SOME DIFFICULTIES AND MYSTERIES AWAITING THEM THERE.

THE beach opposite Newlyn presented a busy scene when Oliver Trembath and his friend Charlie Tregarthen reached it.

Although the zenith of the season was over, mackerel-fishing was still going on there in full vigour, and immense crowds of men, women, and children covered the sands. The village lies on the heights above, and crowds of people were leaning over the iron rails which guard the unwary or unsteady passenger from falling into the sea below. A steep causeway connects the main street above with the shore beneath; and up and down it horses, carts, and people were hurrying continuously.

True, there was not at that time quite as much bustle as may be witnessed there at the present day. The railway has penetrated these remote regions of the west, and now men work with a degree of feverish haste that was unknown then. While hundreds of little boats (tenders to the large ones) crowd in on the beach, auctioneers with long heavy boots wade knee-deep into the water, followed and surrounded by purchasers, and, ringing a bell as each boat comes in, shout—

"Now then, five hundred, more or less, in this boat, who bids? Twenty shillings a hundred for five hundred—twenty shillings—say nineteen—I'm bid nineteen—nineteen and six—say nineteen an'—twenty—twenty shillings I'm bid—say twenty-one—shall I make it twenty-one shillings for any person?" etc.

The bells and voices of these auctioneers, loud though they be, are mild compared with the shouts of men, women, and children, as the fish are packed in baskets, with hot haste, to be in time for the train; and horses with laden carts gallop away over the sands at furious speed, while others come dashing back for more fish. And there is need for all this furious haste, for trains, like time and tide, wait for no man, and prices vary according to trains. Just before the starting of one, you will hear the auctioneers put the fish up at 20s., 25s., and even 30s. a hundred, and in the next half-hour, after the train is gone, and no chance remains of any more of the fish being got into the London market by the following morning, the price suddenly falls to 8s. a hundred, sometimes even less. There is need for haste, too, because the quantity of fish is very great, for there are sometimes two hundred boats at anchor in the bay, each with four thousand fish on the average, which must all be washed and packed in four or five hours. Yes, the old days cannot be compared with the present times, when, between the months of April and June, the three hundred boats of Mounts Bay will land little short of three thousand tons of mackerel, and the railway, for the mere carriage of these to London, Manchester, Birmingham, etc., will clear above £20,000!

Nevertheless, the busy, bustling, hearty nature of the scene on Newlyn beach in days of yore was not so very different as one might suppose from that of the present time. The men were not less energetic then than now; the women were not less eager; the children were quite as wild and mischievous, and the bustle and noise apparently, if not really, as great.

"What interests you?" asked Charlie Tregarthen, observing that his companion gazed pointedly at some object in the midst of the crowd.

"That old woman," said Oliver; "see how demurely she sits on yonder upturned basket, knitting with all her might."

"In the midst of chaos," observed Tregarthen, laughing; "and she looks as placidly indifferent to the noise around her as if it were only the murmuring of a summer breeze, although there are two boys yelling at her very ear at this moment."

"Perhaps she's deaf," suggested Oliver.

Tregarthen said he thought this highly probable, and the two remained silent for some time, watching, from an elevated position on the road leading down to the sands, the ever-changing and amusing scene below. Talk of a pantomime, indeed! No Christmas pantomime ever got up in the great metropolis was half so amusing or so grand as that summer pantomime that was performed daily on Newlyn sands, with admission to all parts of the house—the stage included—for nothing! The scenery was painted with gorgeous splendour by Nature, and embraced the picturesque village of Newlyn, with its irregular gables, variously tinted roofs, and whitewashed fronts; the little pier with its modest harbour,. perfectly dry because of the tide being out, but which, even if the tide had been in, and itself full to overflowing, could not apparently have held more than a dozen of the larger fishing-boats; the calm bay crowded with boats of all sizes, their brown and yellow sails reflected in the clear water, and each boat resting on its own image. On the far-off horizon might be seen the Lizard Point and the open sea, over which hung red and lurid clouds, which betokened the approach of a storm, although, at the time, all nature was quiet and peaceful. Yes, the scenery was admirably painted, and nothing could exceed the perfection of the acting. It was so *very* true to nature!

Right in front of the spot where the two friends stood, a fisherman sat astride of an upturned basket, enjoying a cup of tea which had been brought to him by a little girl who sat on another upturned basket at his side, gazing with a pleased expression into his rugged countenance, one cheek of which was distended with a preposterously large bite of bread and butter. The great Mathews himself never acted his part so well. What admirable devotion to the one engrossing object in hand! What a perfect and convincing display of a hearty appetite! What obvious unconsciousness of being looked at, and what a genuine and sudden burst of indignation when, owing to a touch of carelessness, he capsized the cup, and poured the precious tea upon the thirsty sand. At the distance from which Oliver and his friend observed him, no words were audible, but none were necessary. The man's acting was so perfect that they knew he was scolding the little girl for the deed which he himself had perpetrated. Then there was something peculiarly touching in the way in which he suddenly broke into a short laugh, and patted the child's head while she wiped out the cup, and refilled it from the little brown broken-nosed tea-pot hitherto concealed under her ragged shawl to keep it warm. No wizard was needed to tell, however, that this was quite an unnecessary piece of carefulness on the little girl's part, for any brown tea-pot in the world, possessing the smallest amount of feeling, would have instantly made hot and strong tea out of cold water on being pressed against the bosom of that sunny child!

Just beyond this couple, three tired men, in blue flannel shirts, long boots, and sou'-westers, grouped themselves round a bundle of straw to enjoy a pipe; one stretched himself almost at full length on it, in lazy nonchalance; another sat down on it, and, resting his elbows on his knees, gazed pensively at his pipe as he filled it, while the third thrust his hands into his pockets, and stood for a few seconds with a grand bend at the small of his back (as if he felt that his muscles worked easily), and gazed out to sea. The greatest of the old masters could have painted nothing finer.

Away to the right, an old man might be seen tying up the lid of a basket full of fish beside his cart, and dividing his attention between the basket and the horse, which latter, much to his surprise, was unwontedly restive that evening, and required an unusual number of cautions to remain still, and of threats as to the punishment that would follow continued disobedience, all of which afforded the most intense and unutterable delight to a very small precocious boy, who, standing concealed on the off side of the animal, tickled its ear with a straw every time it bent its head towards the bundle of hay which lay at its feet. No clown or pantaloon was there to inflict condign punishment, because none were needed. A brother carter standing by performed the part, extempore. His eye suddenly lit on the culprit; his whip sprang into the air and descended on the urchin's breech. Horror-struck, his mouth oped responsive to the crack, and a yell came forth that rose high above the surrounding din, while his little legs carried him away over the sands like a ragged leaf driven before the wind.

To the left of this scene (and ignorant of it, for the stage was so large, the actors were so numerous, and the play so grand, that few could do more than attend to their own part) a cripple might be seen with a crutch hopping actively about. He was a young man; had lost his leg, by an accident probably, and was looking about for a cast-away fish for his own supper. He soon found one. Whether it was that one had been dropped accidentally, or that some generous-hearted fish-dealer had dropped one on purpose, we cannot tell, but he did get one —a large fat one too,—and hobbled away as quickly as he could, evidently rejoicing.

The cripple was not the only one who crossed the stage thus lightly burdened. There were several halt and maimed, and some blind and aged ones there, whose desires in regard to piscatorial wealth extended only to one, or perhaps two, and they all got what they wanted. That was sufficient for the evening's supper—for the morrow there was no need to care; they could return to get a fresh supply evening after evening for many a day to come, for it was a splendid mackerel season—such as had not been for many years—so said the sages of the village

There were other groups, and other incidents that would have drawn laughter as well as tears from sympathetic hearts, but we must forbear. The play was long of being acted out—it was no common play; besides, it is time for *our* actors to come upon the stage themselves.

"I see old Hitchin," exclaimed Oliver Trembath, starting suddenly out of a reverie, and pointing into the thickest of the crowd.

"How can you tell? you don't know him," said his companion.

"Know him! Of course I do; who could fail to know him after the graphic description the lawyer gave of him; see—look yonder, beside the cart with the big man in it arranging baskets. D' you see?"

"Which? the one painted green, and a scraggy horse with a bag hanging to its nose?"

"No, no; a little further to the left, man; the one with the broken rail and the high-spirited horse. There, there he is; a thin dried-up wrinkled old shabby—"

"Ah! that's the man," exclaimed Tregarthen.

laughing; "come along and let's try to keep our eyes on him, for there is nothing so difficult as finding any one in a crowd."

The difficulty referred to was speedily illustrated by the fact that the two friends threaded their way to the spot where the cart had stood, and found not only that it was gone, but that Hitchin had also moved away, and although they pushed through the crowd for more than a quarter of an hour they failed to find him.

As they were wandering about thus, they observed a very tall broad-shouldered man talking earnestly in undertones to a sailor-like fellow who was still broader across the shoulders, but not quite so tall. It is probable that Oliver would have paid no attention to them, had not the name of Hitchin struck his ear. Glancing round at the men he observed that the taller of the two was George Tonkin, and the other his friend of the Land's End, the famous Jim Cuttance.

Oliver plucked his companion by the sleeve, and whispered him to stand still. Only a few words and phrases reached them, but these were sufficient to create surprise and arouse suspicion. Once, in particular, Tonkin, who appeared to be losing his temper, raised his voice a little, exclaiming—

"I tell 'ee what it is, Cuttance, I do knaw what you're up to, an' I'll hinder 'ee ef I can."

The man confirmed this statement with a savage oath, to which Cuttance replied in kind; nevertheless he was evidently anxious to conciliate his companion, and spoke so low as to be nearly inaudible. Only the words "Not to-night; I won't do it to-night," reached the ears of the listeners.

At this point Tonkin turned from the smuggler with a fling, muttering in an undertone as he went, "I doan't b'lieve 'ee, Cuttance, for thee 'rt a liard, so I'll watch 'ee, booy."

Oliver was about to follow Tonkin, when he observed Hitchin himself slowly wending his way through the crowd. He had evidently heard nothing of the conversation that appeared to have reference to himself, for he sauntered along with a careless air, and his hands in his pockets, as though he were an uninterested spectator of the busy scene.

Oliver at once accosted him—

"Pray, sir, is your name Hitchin?"

"It is," replied the old man, eyeing his interrogator suspiciously.

"Allow me to introduce myself, sir: Oliver Trembath, nephew to Mr. Thomas Donnithorne of St. Just."

Mr. Hitchin held out his hand, and said that he was happy to meet with a nephew of his old friend, in the tone of a man who would much rather not meet either nephew or uncle.

Oliver felt this, so he put on his most insinuating air, and requested Mr. Hitchin to walk with him a little aside from the crowd, as he had something of a private nature to say to him. The old man agreed, and the two walked slowly along the sands to the outskirts of the crowd, where young Tregarthen discreetly left them.

The moment Oliver broached the subject of the advance of money, Hitchin frowned, and the colour in his face betrayed suppressed anger.

" Sir," said he, " I know all that you would say to me. It has already been said oftener than there is any occasion for. No one appears to believe me when I assert that I have met with heavy losses of late, and have no cash to spare—not even enough to pay my debts."

" Indeed, sir," replied Oliver, " I regret to hear you say so, and I can only apologize for having troubled you on the subject. I assure you nothing would have induced me to do so but regard for my uncle, to whom the continuance of this mine for some time would appear to be a matter of considerable importance, but since you will not—"

" *Will* not !" interrupted Hitchin angrily, " have I not said *cannot ?* I tell you, young man, that there is a scoundrel to whom I owe a large sum for—for —well, no matter what it's for, but the blackguard threatens that if I don't—pshaw !—"

The old man seemed unable to contain himself at this point, for he turned angrily away from Oliver, and, hastening back towards the town, was soon lost again in the crowd.

Oliver was so taken by surprise, that he stood still gazing dreamily at the point where Hitchin had disappeared, until he was roused by a touch on the shoulder from Charlie Tregarthen.

"Well," said he, smiling, "how fares your suit?"

Oliver replied by a burst of laughter.

"How fares my suit?" he repeated; "badly, very badly indeed; why, the old fellow's monkey got up the moment I broached the subject, and I was just in the middle of what I meant to be a most conciliating speech, when he flung off as you have seen."

"Odd, very odd," said Tregarthen, "to see how some men cling to their money, as if it were their life. After all, it *is* life to some—at least all the life they have got."

"Come now, don't moralize, Charlie, for we must act just now."

"I'm ready to act in any way you propose, Oliver; what do you intend to do? Issue your commands, and I'll obey. Shall we attack the village of Newlyn single-handed, and set fire to it, as did the Spaniards of old, or shall we swim off to the fleet of boats, cut the cables, bind the men in charge, and set sail for the mackerel-fishing?"

"Neither, my chum, and especially not the latter, seeing that a thunder-cloud is about to break over the sea ere long, if I do not greatly misjudge appearances in the sky; but, man, we must see this testy old fellow again, and warn him of the danger which threatens him. I feel assured that that rascal Cuttance means him harm, for he let something fall in his anger, which, coupled with what we have already heard from the smuggler himself, and from Tonkin, convinces me that evil is in the wind. Now the question is, how are we to find him, for searching in that crowd is almost useless."

"Let us go to his house," suggested Tregarthen, "and if he is not at home, wait for him."

"Do you know where his house is ?"

"No, not I."

"Then we must inquire, so come along."

Pushing once more through the throng of busy men and women, the friends ascended the sloping causeway that led to the village, and here asked the first man they met where Mr. Hitchin lived.

"Right over top o' hill," replied the man.

"Thank you. That'll do, Charlie, come along," said Oliver, turning into one of the narrow passages that diverged from the main street of Newlyn, and ascending the hill with giant strides; "one should never be particular in their inquiries after a place. When I'm told to turn to the right after the second turning to the left, and that if I go right on till I come to some other turning, that will conduct me point blank to the street that enters the square near to which lies the spot I wish to reach, I'm apt to get confused. Get a general direction if possible, the position indicated by compass is almost enough, and *ask again.* That's my plan, and I never found it fail."

CHAPTER XXIII.

IN WHICH IS RECORDED A VISIT TO AN INFANT-SCHOOL, A WARNING TO A THANKLESS OLD GENTLEMAN; ALSO A STORM, AND A SUDDEN AS WELL AS SURPRISING END OF A MINE, BESIDES DARK DESIGNS.

OLIVER TREMBATH'S plan of "asking again" had to be put in practice sooner than had been anticipated, for the back alleys and lanes of Newlyn were a little perplexing to a stranger.

"Let us inquire here," said Tregarthen, "seeing the half-open door of a very small cottage, with part of a woman's back visible in the interior.

"By all means," said Oliver, pushing open the door and stooping low as he entered.

The visitors were instantly transfixed by thirty pair of eyes—all of them bright blue, or bright black—few of them elevated much more than two feet from the ground, and not one of them dimmed by the smallest approach to a wink. Nay, on the contrary, they all opened so wide when the strangers entered that it seemed as if either winking or shutting were in future out of the question, and that to sleep with eyes wide-open was the sad prospect of the owners thereof in all time coming.

"An infant-school," murmured Tregarthen.

The very smallest boy in the school—an infant with legs about five inches long, who sat on a stool not more than three inches high—appeared to understand what he said, and to regard it as a personal insult, for he at once began to cry. A little girl with bright red hair, a lovely complexion, and a body so small as to be scarce worth mentioning, immediately embraced the small boy, whereupon he dried his eyes without delay.

"You have a nice little school here," said Oliver.

"Iss, sur, we do feel proud of it," said the good-looking motherly dame in charge, with a little twitch of her shoulders, which revealed the horrible fact that both her arms had been taken off above the elbows, "the child'n are very good, and they do sing bootiful. Now then, let the gentlemen hear you—'O that'll be'—come."

Instantly, and in every possible pitch, the thirty mouths belonging to the thirty pair of eyes opened, and "O that will be joyful," etc., burst forth with thrilling power. A few leading voices gradually turned the torrent into a united channel, and before the second verse was reached the hymn was tunefully sung, the sweet voice of the little girl with the bright hair being particularly distinguishable, and the shrill pipe of the smallest boy sounding high above the rest as he sang "O that will be doyful,

doyful, doyful, doyful," with all his might and main.

When this was finished Tregarthen asked the schoolmistress what misfortune had caused the loss of her arms, to which she replied that she had lost them in a coach accident. As she was beginning to relate the history of this sad affair, Oliver broke in with a question as to where old Mr. Hitchin's house was. Being directed to it they took leave of the infant-school, and soon found themselves before the door of a small cottage. They were at once admitted to the presence of the testy old Hitchin, who chanced to be smoking a pipe at the time. He did not by any means bestow a welcome look on his visitors, but Oliver, nevertheless, advanced and sat down in a chair before him.

"I have called, Mr. Hitchin," he began, "not to trouble you about the matter which displeased you when we conversed together on the beach, but to warn you of a danger which I fear threatens yourself."

"What danger may that be?" inquired Hitchin, in the tone of a man who held all danger in contempt.

"What it is I cannot tell, but—."

"Cannot tell!" interrupted the old man; "then what's the use of troubling me about it?"

"Neither can I tell of what use my troubling you may be," retorted Oliver with provoking coolness.

"but I heard the man speak of you on the beach less than an hour ago, and as you referred to him yourself I thought it right to call—."

At this point Hitchin again broke in—

"Heard a man speak of me—what man? Really, Mr. Trembath, your conduct appears strange to me. Will you explain yourself?"

"Certainly. I was going to have added, if your irascible temper would have allowed me, that the notorious smuggler Jim Cuttance—."

Oliver stopped, for at the mention of the smuggler's name the pipe dropped from the old man's mouth, and his face grew pale.

"Jim Cuttance!" he exclaimed after a moment's pause; "the villain, the scoundrel—what of him? what of him? No good, I warrant. There is not a rogue unhanged who deserves more richly to swing at the yard-arm than Jim Cuttance. What said he about me?"

When he finished this sentence the old man's composure was somewhat restored. He took a new pipe from the chimney-piece, and began to fill it, while Oliver related all that he knew of the conversation between the two smugglers.

When he had finished Hitchin smoked for some minutes in silence.

"Do you really think," he said at length, "that the man means to do me bodily harm?"

"I cannot tell," replied Oliver; "you can form your own judgment of the matter more correctly than I can, but I would advise you to be on your guard."

"What says your friend?" asked Hitchin, turning towards Tregarthen, of whom, up to that point, he had taken no notice.

Thus appealed to, the youth echoed Oliver's opinion, and added that the remark of Cuttance about his intention not to do something unknown *that* night, and George Tonkin's muttered expressions of disbelief and an intention to watch, seemed to him sufficient to warrant unusual caution in the matter of locks, bolts, and bars.

As he spoke there came a blinding flash of lightning, followed by a loud and prolonged peal of thunder.

Oliver sprang up.

"We must bid you good-night," he said, "for we have to walk to St. Just, and don't wish to get more of the storm than we can avoid."

"But you cannot escape it," said Hitchin.

"Nevertheless we can go as far as possible before it begins, and then take shelter under a bush or hedge, or in a house if we chance to be near one. I would rather walk in rain any day than drive in a kittereen!"

"Pray be persuaded to stop where you are, gentlemen," said the old man in a tone of voice that was marvellously altered for the better. "I can offer you comfortable quarters for the night, and good, though plain fare, with smuggled brandy of the best, and tobacco to match."

Still Oliver and Tregarthen persisted in their resolution to leave, until Hitchin began to plead in a tone that showed he was anxious to have their presence in the house as protectors. Then their resolution began to waver, and when the old man hinted that they might thus find time to reconsider the matter of the Wherry Mine, they finally gave in, and made up their minds to stay all night.

According to the opinion of a celebrated poet, the best-laid plans of men as well as mice are apt to miscarry. That night the elements contrived to throw men's calculations out of joint, and to render their cupidity, villany, and wisdom, alike ineffectual.

A storm, the fiercest that had visited them for many years, burst that night on the southern shores of England, and strewed her rocks and sands with wrecks and dead bodies. Nothing new in this, alas! as all know who dwell upon our shores, or who take an interest in, and read the records of, our royal and noble Lifeboat Institution. But with this great subject we have not to do just now, further than to observe, as we have said before, that in those days there were no lifeboats on the coast.

Under the shelter of an old house on the shore at Penzance were gathered together a huge concourse of townspeople and seafaring men, watching the storm. It was a grand and awful sight,—one fitted to irresistibly solemnize the mind, and incline it, unless the heart be utterly hardened, to think of the great Creator and of the unseen world, which seems at such a season to be brought impressively near

The night was extremely dark, and the lightning, by contrast, peculiarly vivid. Each flash appeared to fill the world for a moment with lambent fire, leaving the painful impression on observers of having been struck with total blindness for a few seconds after, and each thunder-clap came like the bursting of artillery, with scarcely an interval between the flash and crash, while the wind blew with almost tropical fury.

The terrible turmoil and noise were enhanced tenfold by the raging surf, which flew up over the roadway, and sent the spray high above and beyond the tops of the houses nearest to the shore.

The old house creaked and groaned in the blast as if it would come down, and the men taking shelter there looked out to sea in silence. The bronzed veterans there knew full well that at that hour many a despairing cry was being uttered, many a hand was stretched wildly, helplessly, and hopelessly from the midst of the boiling surf, and many a soul was passing into eternity. They would have been ready, then as well as now, to have risked life and limb to save fellow-creatures from the sea, but ordinary boats they knew could not live in such a storm.

Among the watchers there stood Jim Cuttance. He had been drinking at a public-house in Penzance, and was at the time, to use his own expression, "three sheets in the wind," *i.e.*, about half-drunk. What his business was nobody knew, and we shall not inquire, but he was the first to express his belief that the turret and bridge of the Wherry Mine would give way. As he spoke a vivid flash of lightning revealed the stout timbers of the mine standing bravely in the storm, each beam and chain painted black and sharp against the illumined sky and the foaming sea.

"She have stud out many a gale," observed a weather-beaten old seaman; "p'raps she won't go down yet."

"I do hope she won't," observed another.

"She haven't got a chance," said Cuttance.

Just then another flash came, and there arose a sharp cry of alarm from the crowd, for a ship was seen driving before the gale close in upon the land, so close that she seemed to have risen there by magic, and appeared to tower almost over the heads of the people. The moments of darkness that succeeded were spent in breathless, intense anxiety. The flashes, which had been fast enough before, seemed to have ceased altogether now; but again the lightning gleamed—bright as full moonlight, and again the ship was seen, nearer than before—close on the bridge of the mine.

"'Tis the Yankee ship broken from her anchors in Gwavus Lake," exclaimed a voice.

The thunder-peal that followed was succeeded by a crash of rending timber and flying bolts that almost emulated the thunder. Certainly it told with greater power on the nerves of those who heard it.

Once again the lightning flashed, and for a moment the American vessel was seen driving away before the wind, but no vestige of Wherry Mine remained. The bridge and all connected with it had been completely carried away, and its shattered remnants were engulfed in the foaming sea.

It deserved a better fate; but its course was run, and its hour had come. It passed away that stormy night, and now nothing remains but a few indications of its shaft-mouth, visible at low water, to tell of one of the boldest and most singular of mining enterprises ever undertaken and carried out by man.

There was one spectator of this imposing scene who was not very deeply impressed by it. Jim Cuttance cared not a straw for storms or wrecks, so long as he himself was safe from their influence.

Besides, he had other work in hand that night, so he left the watchers on the beach soon after the destruction of the bridge. Buttoning his coat up to the neck, and pulling his sou'-wester tight over his brows, he walked smartly along the road to Newlyn, while many of the fishermen ran down to the beach to render help to the vessel.

Between the town of Penzance and the village of Newlyn several old boats lay on the grass above high-water mark. Here the smuggler stopped and gave a loud whistle. He listened a moment and then repeated it still louder. He was answered by a similar signal, and four men in sailor's garb, issuing from behind one of the boats, advanced to meet him.

"All right, Bill?" inquired Cuttance.

"All right, sur," was the reply.

"Didn't I tell 'ee to leave them things behind?" said Cuttance sternly, as he pointed to the butt of a pistol which protruded from the breast-pocket of one of the men; "sure we don't require powder and lead to overcome an old man!"

"No more do we need a party o' five to do it," replied the man doggedly.

To this Cuttance vouchsafed no reply, but, plucking the weapon from the man, he tossed it far into the sea, and, without further remark, walked towards the fishing village, followed by his men.

By this time the thunder and rain had abated considerably, but the gale blew with increased violence, and, as there was neither moon nor stars, the darkness was so intense that men less acquainted with the locality would have been obliged to proceed with caution. But the smugglers knew every foot of the ground between the Lizard and the Land's End, and they advanced with rapid strides until they reached the low wall that encompassed, but could not be said to guard, old Mr. Hitchin's garden-plot.

The hour was suited for deeds of darkness, being a little after midnight, and the noise of the gale favoured the burglars who leaped the wall with ease and approached the back of the cottage.

In ordinary circumstances Hitchin would have been in bed, and Cuttance knew his habits sufficiently to be aware of this; his surprise, therefore, was great when he found lights burning, and greater still when, peeping through a chink of the window-shutter, he observed two stout fellows seated at the old man's table. Charles Tregarthen he had never seen before, and, as Oliver Trembath sat with his back to the window, he could not recognise him.

"There's company wi' the owld man," said Cuttance, returning to his comrades; "two men, young and stout, but we do knaw how to manage they!"

This was said by way of an appeal, and was received with a grin by the others, and a brief recommendation to go to work without delay.

For a few minutes they whispered together as to the plan of attack, and then, having agreed on that point, they separated. Cuttance and the man whom he had called Bill, went to the window of the room in which Hitchin and his guests were seated, and stationed themselves on either side of it. The sill was not more than breast high. The other three men quickly returned, bearing a heavy boat's-mast, which they meant to use as a battering-ram. It had been arranged that Cuttance should throw up the window, and, at the same moment, his comrades should rush at the shutter with the mast. The leader could not see their faces, but there was light sufficient to enable him to distinguish their dark forms standing in the attitude of readiness. He therefore stepped forward and made a powerful effort to force up the window, but it resisted him, although it shook violently.

Those inside sprang up at the sound, and the smugglers sank down, as if by mutual consent, among the bushes which grew thickly near the window.

"I told you it was only the wind," said Oliver Trembath, who had opened the shutters and gazed through the window for some time into the darkness, where, of course, he saw nothing.

Well was it for him that Cuttance refused to follow Bill's advice, which was to charge him through the window with the mast. The former knew that, with the window fastened, it would be impossible to force an entrance in the face of such a youth as Tregarthen, even although they succeeded in rendering the other *hors de combat*, so he restrained Bill, and awaited his opportunity.

Oliver's remark appeared to be corroborated by a gust of wind which came while he was speaking, and shook the window-frame violently.

"There it is again," he said, turning to his host with a smile. "Depend upon it, they won't trouble you on such a night as this."

He closed and re-fastened the shutters as he spoke, and they all returned to their places at the table.

Unfortunately Oliver had not thought of examining the fastening of the window itself. Had he done so, he would have seen that it was almost wrenched away. Cuttance saw this, however, and resolved to make sure work of it next time.

When the men with the battering-ram were again in position, he and Bill applied their united strength to the window, and it instantly flew up to the top. At same moment, bolts and bars gave way, and the shutters went in with a crash. Making use of the mast as a rest, Cuttance sprang on the window-sill and leaped into the room.

The whole thing was done with such speed, and, if we may so express it, with such simultaneity of action, that the bold smuggler stood before the astonished inmates almost as soon as they could leap from their chairs. Cuttance ducked to evade a terrific blow which Oliver aimed at him with his fist, and in another instant grappled with him. Tregarthen rushed to the window in time to meet Bill, on whose forehead he planted a blow so effectual that that worthy fell back into the arms of his friends, who considerately let him drop to the ground, and made a united assault on Charlie.

Had Oliver Trembath possessed his wonted vigour, he would speedily have overcome his adversary despite his great strength, but his recent illness had weakened him a little, so that the two were pretty equally matched. The consequence was that, neither daring to loosen his hold in order to strike an effective blow, each had to devote all his energies to throw the other, in which effort they wrenched, thrust, and swung each other so violently round the room that chairs and tables were overturned and smashed, and poor old Hitchin had enough to do to avoid being floored in the *mêlée*, and to preserve from destruction the candle which lighted the scene of the combat.

At first Oliver had tried to free his right hand in order to strike, but, finding this impossible, he attempted to throw the smuggler, and, with this end in view, lifted him bodily in the air and dashed him down, but Cuttance managed to throw out a leg and meet the ground with his foot, which saved him. He was a noted wrestler. He could give the famous Cornish hug with the fervour of a black bear, and knew all the mysteries of the science. Often had he displayed his great muscular power and skill in the ring, where "wrestlers" were wont to engage in those combats of which the poet writes:—

> "They rush, impetuous, with a shock
> Their arms implicit, rigid, lock;
> They twist; they trip; their limbs are mixed.
> As one they move; as one stand fixed.
> Now plant their feet in wider space,
> And stand like statues on their base."

But never before had Jim Cuttance had to deal with such a man as Oliver Trembath, who swung him about among the chairs, and crashed him through the tables, until, seizing a sudden opportunity, he succeeded in flinging him flat on the floor, where he held him down, and planted his knee on his chest with such force that he nearly squeezed all the breath out of him.

No word did Jim Cuttance utter, for he was incapable of speech, but the colour of his face and his protruding tongue induced Oliver to remove his knee.

Meanwhile Charlie Tregarthen had enough to do at the window. After he had tumbled Bill out, as we have described, two of the other men sprang at him, and, seizing him by the collar of his coat, attempted to drag him out. One of these he succeeded in overthrowing by a kick on the chest, but his place was instantly taken by the third of the bearers of the battering-ram, and for a few minutes the struggle was fierce but undecided. Suddenly there arose a great shout, and all three tumbled heads over heels into the shrubbery.

It was at this moment that Oliver rose from his prostrate foe. He at once sprang to the rescue; leaped out of the window, and was in the act of launching a blow at the head of the first man he encountered, when a voice shouted—

"Hold on, sur."

It is certain that Oliver would have declined to hold on, had not the voice sounded familiar. He held his hand, and next moment Charlie appeared in the light of the window dragging a struggling man after him by the nape of the neck. At the same time George Tonkin came forward trailing another man by the hair of the head.

"Has Cuttance got off?" inquired Tonkin.

"No," replied Oliver, leaping back into the room, just in time to prevent Jim, who had recovered, from making his escape.

"Now, my man, keep quiet," said Oliver, thrusting him down into a chair. "You and I have met before, and you know that it is useless to attempt resistance."

Cuttance vouchsafed no reply, but sat still with a dogged expression on his weather-beaten visage.

Hitchin, whose nerves were much shaken by the scene of which he had been a trembling spectator, soon produced ropes, with which the prisoners were bound, and then they were conducted to a place of safe keeping—each of the victors leading the man he had secured, and old Hitchin going before—an excited advance-guard. The two men whom Tregarthen knocked down had recovered, and made their escape just before the fight closed.

Oliver Trembath walked first in the procession, leading Jim Cuttance.

"I gave you credit for a more manly spirit than this," said Oliver, as he walked along. "How could you make so cowardly an attack on an old man?"

Cuttance made no reply, and Oliver felt sorry that he had spoken, for the remembrance of the incident at the Land's End was strong upon him, and he would have given all he possessed to have had no hand in delivering the smuggler up to justice. At the same time he felt that the attempt of Cuttance was a dastardly one, and that duty required him to act as he did.

It seemed to Oliver as if George Tonkin had divined his thoughts, for at that moment he pushed close to him and whispered in his ear—

"Jim Cuttance didn't mean to rob th' owld man, sur. He only wanted to give he a fright, an' make un pay what he did owe un."

This was a new light on the subject to Oliver, who at once formed his resolution and acted on it.

"Cuttance," he said, "it is not unlikely that, if brought to justice, you will swing for this night's adventure."

He paused and glanced at the face of his prisoner, who still maintained rigid silence.

"Well," continued our hero, "I believe that your intentions against Mr. Hitchin were not so bad as they would appear to be—"

"Who told 'ee that?" asked the smuggler sternly.

"No matter," replied Oliver, drawing a knife from his pocket, with which he deliberately cut the cords that bound his prisoner. "There—you are free. I hope that you will make better use of your freedom in time to come than you have in time past, although I doubt it much; but remember that I have repaid the debt I owe you."

"Nay," replied Cuttance, still continuing to walk close to his companion's side. "I did give you life. You have but given me liberty."

"I'd advise you to take advantage of that liberty without delay," said Oliver, somewhat nettled by the man's remark, as well as by his cool composure, "else your liberty may be again taken from you, in which case I would not give much for your life."

"If you do not assist, there is no one here who can take me *now*," replied Cuttance, with a smile. "However, I'm not ungrateful—good-night."

As he said this, the smuggler turned sharp to the right into one of the numerous narrow passages which divide the dwellings of Newlyn, and disappeared.

Charles Tregarthen, who was as sharp as a needle, observed this, and, leaving his man in charge of Tonkin, darted after the fugitive. He soon returned, however, wiping the perspiration from his brow, and declaring that he had wellnigh lost himself in his vain endeavours to find the smuggler.

"How in all the world did you manage to let him go?" he demanded somewhat sharply of Oliver.

"Why, Charlie," replied his friend, with a laugh, "you know I have not been trained to the duties of a policeman, and it has always been said that Jim Cuttance was a slippery eel. However, he's gone now, so we had better have the others placed in safe custody as soon as possible."

Saying this he passed his arm through that of old Mr. Hitchin, and soon after the smugglers were duly incarcerated in the lock-up of Penzance.

CHAPTER XXIV.

EXHIBITS THE MANAGING DIRECTOR AND THE SECRETARY OF WHEAL DOOEM IN CONFIDENTIAL CIRCUMSTANCES, AND INTRODUCES THE SUBJECT OF "LOCALS."

ABOUT this time, that energetic promoter of mining operations, Mr. George Augustus Clearemout, found it necessary to revisit Cornwall.

He was seated in an easy-chair in a snug little back-office, or board-room, in one of the airiest little streets of the City of London, when this necessity became apparent to him. Mr. Clearemout did not appear to have much to do at that particular time, for he contented himself with tapping the arm of his easy-chair with the knuckles of his right hand, while he twirled his gold watch-key with his left, and smiled occasionally.

To judge from appearances it seemed that things in general were prospering with George Augustus. Everything about him was new, and, we might almost say, gorgeous. His coat and vest and pantaloons had a look and a cut about them that told of an extremely fashionable tailor, and a correspondingly fashionable price. His rings, of which he wore several, were massive, one of them being a diamond ring of considerable value. His boots were faultlessly made, quite new, and polished so highly that it dazzled one to look at them, while his linen, of which he displayed a large quantity on the breast, was as white as snow—not London snow, of course! Altogether Mr. G. A. Clearemout was a most imposing personage.

"Come in," he said, in a voice that sounded like the deep soft whisper of a trombone.

The individual who had occasioned the command by tapping at the door, opened it just enough to admit his head, which he thrust into the room. It was a shaggy red head belonging to a lad of apparently eighteen; its chief characteristics being a prolonged nose and a retracted chin, with a gash for a mouth, and two blue holes for eyes.

"Please, sir, Mr. Muddle," said the youth.

"Admit Mr. Muddle."

The head disappeared, and immediately after a gentleman sauntered into the room, and flung himself lazily into the empty arm-chair which stood at the fireplace, *vis-à-vis* to the one in which Mr. Clearemout sat, explaining that he would not have been so ceremonious had he not fancied that his friend was engaged with some one on business.

"How are you, Jack?" said George Augustus.

"Pretty bobbish," replied Jack. (He was the same Jack whom we have already introduced as being Mr. Clearemout's friend and kindred spirit.)

"Any news?" inquired Mr. Clearemout.

"No, nothing moving," said Jack languidly.

"H'm, I see it is time to stir now, Jack, for the wheel of fortune is apt to get stiff and creaky if we don't grease her now and then and give her a jog. Here is a little pot of grease which I have been concocting and intend to lay on immediately."

He took a slip of paper from a large pocket-book which lay at his elbow on the new green-cloth-covered table, and handed it to his friend, who slowly opened and read it in a slovenly way, mumbling the most of it as he went on—

"'WHEAL DOOEM,

In St. Just, Cornwall — mumble — m — m — in 10,000 shares. An old mine, m—m—every reason to believe—m—m—splendid lodes visible from— m —m. Depth of Adit fifty fathoms—m—depth below Adit ninety fathoms. Pumps, whims, engines, etc., in good working order,—m—little expense—Landowners, Messrs.—m—Manager at the Mine, Captain Trembleforem—m—thirteen men, four females and two boys—m—water-wheels—stamps—m—Managing Director, George Augustus Clearemout, Esq., 99 New Gull Street, London,—m—Secretary, John Muddle, Esq.—ahem!——'

"But, I say, it won't do to publish anything of this sort just yet, you know," said Secretary Jack in a remonstrative tone, "for there's nothing doing at all I believe."

"I beg your pardon," replied the managing director, "there is a good deal doing. I have written to St. Just appointing the local manager, and it is probable that things are really under weigh by this time; besides, I shall set out for Cornwall to-morrow to superintend matters, leaving my able secretary in charge here in the meantime, and when he hears from me this paper may be completed and advertised."

"I say, it looks awful real-like, don't it?" said Jack, with a grin. "Only fancy if it should turn out to be a good mine after all—what a lark *that* would be! and it might, you know, for it *was* a real one once, wasn't it? And if you set a few fellows to sink the what-d'ye-call-'ems and drive the thingumbobs, it is possible they may come upon tin or copper, or something of that sort—wouldn't it be jolly?"

"Of course it would, and that is the very thing that gives zest to it. It's a speculation, not a swindle by any means, and admirably suits our easy consciences. But, I say, Jack, you *must* break yourself of talking slang. It will never do to have the secretary of the Great Wheal Dooem Mining

Company talking like a street boy. Besides, I hate slang even in a blackguard—not to mention a blackleg,—so you must give it up, Jack, you really must, else you'll ruin the concern at the very beginning."

Secretary Jack started into animation at this.

"Why, George," he said, drawing himself up, "I can throw it off when I please. Look here—suppose yourself an inquiring speculator—ahem! I assure you, sir, that the prospects of this mine are most brilliant, and the discoveries that have been made in it since we commenced operations are incredible—absolutely incredible, sir. Some of the lodes (that's the word, isn't it?) are immensely rich, and upwards of a hundred feet thick, while the part that runs under the sea, or *is* to run under the sea, at a depth of three thousand fathoms, is probably as rich in copper ore as the celebrated Botallack, whose majestic headland, bristling with machinery, overhangs the raging billows of the wide Atlantic, etc. etc. Oh! George, it's a great lark entirely."

"You'll have to learn your lesson a little better, else you'll make a great mess of it," said Clearemout.

"A muddle of it—according to my name and destiny, George," said the secretary, "a muddle of it, and a fortune *by* it."

Here the secretary threw himself back in the easy-chair, and grinned at the opposite wall, where his eye fell on a large picture, which changed the grin into a stare of surprise.

"What have we here, George," he said, rising, and fitting a gold glass in his eye,—"not a portrait of Wheal Dooem, is it?"

"You have guessed right," replied the other. "I made a few sketches on the spot, and got a celebrated artist to put them together, which he has done, you see, with considerable effect. Here, in the foreground, you observe," continued the managing director, taking up a new white pointer, "stands Wheal Dooem, on a prominent crag overlooking the Atlantic, with Gurnard's Head just beyond. Farther over, we have the celebrated Levant Mine, and the famous Botallack, and the great Wheal Owles, and a crowd of other more or less noted mines, with Cape Cornwall, and the Land's End, and Tolpedenpenwith in the middle-distance, and the celebrated Logan Rock behind them, while we have Mounts Bay, with the beautiful town of Penzance, and St. Michael's Mount, and the Lizard in the background, with France in the remote distance."

"Dear, *dear* me! quite a geographical study, I declare," exclaimed Secretary Jack, examining the painting with some care. "Can you really see all these places at once from Wheal Dooem?"

"Not exactly from Wheal Dooem, Jack, but if you were to go up in a balloon a few hundred yards above the spot where it stands, you might see 'em all on a very clear day, if your eyes were good. The fact is, that I regard this picture as a triumph of art, exhibiting powerfully what is by artists termed 'bringing together' and great 'breadth,' united with exceedingly minute detail. The colouring, too, is high—very high indeed, and the *chiaroscuro* is perfect—"

"Ha!" interposed Jack, all the *chiar* being on the surface, and the *oscuro* down in the mine, eh?"

"Exactly so," replied Clearemout. "It is a splendid picture. The artist regards it as his *chef d'œuvre*, and you must explain it to all who come to the office, as well as those magnificent geological sections rolled up in the corner, which it would be well, by the way, to have hung up without delay. They arrived only this morning. And now, Jack, having explained these matters, I will leave you to study them at your leisure, and go prepare for my journey to Cornwall, where, by the way, I have my eye upon a sweet little girl, whose uncle, I believe, has lots of tin, both in the real and figurative sense of the word. Something may come of it—who knows?"

Next morning saw the managing director on the road, and in due time he found his way by coach, kittereen, and gig to St. Just, where, as before, he was hospitably received by old Mr. Donnithorne.

That gentleman's buoyancy of spirit, however, was not quite so great as it had been a few months before, but that did not much affect the spirits of Clearemout, who found good Mrs. Donnithorne as motherly, and Rose Ellis as sweet, as ever.

It happened at this time that Oliver Trembath had occasion to go to London about some matter relating to his deceased mother's affairs, so the managing director had the field all to himself. He therefore spent his time agreeably in looking after the affairs of Wheal Dooem during the day, and making love to Rose Ellis in the evening.

Poor Rose was by no means a flirt, but she was an innocent, straightforward girl, ignorant of many of the world's ways, and of a trusting disposition. She found the conversation of Mr. Clearemout agreeable, and did not attempt to conceal the fact. Mr. Clearemout's vanity induced him to set this down to a tender feeling, although Rose never consciously gave him, by word or look, the slightest reason to come to such a conclusion.

One forenoon Mr. Clearemout was sitting in Mr. Donnithorne's dining-room conversing with Rose and Mrs. Donnithorne, when the old gentleman entered and sat down beside them.

"I had almost forgotten the original object of my visit this morning," said the managing director, with a smile, and a glance at Rose; "the fact is that I am in want of a man to work at Wheal Dooem, a steady trustworthy man, who would be fit to take charge—become a sort of overseer; can you recommend one?"

Mr. Donnithorne paused for a moment to reflect, but Mrs. D. deeming reflection quite unnecessary, at once replied—

"Why, there are many such men in St. Just. There's John Cock, as good a man as you could find in all the parish, and David Trevarrow, and James Penrose—he's a first-rate man. You remember him, my dear? (turning to her worse half)—one of our locals, you know."

"Yes, my dear, I remember him perfectly.—You could not, Mr. Clearemout, get a better man, I should say."

"I think you observed, madam," said Mr. Clearemout, "that this man is a 'local.' Pray what is a local?"

Rose gave one of her little laughs at this point, and her worthy aunt exclaimed—

"La! Mr. Clearemout, don't you know what a local preacher is?"

"Oh! a *preacher?* Connected with the Methodist body, I presume?"

"Yes, and a first-rate man, I assure you."

"But," said Mr. Clearemout, with a smile, "I want a miner, not a preacher."

"Well, he is a miner, and a good one too—"

"Allow *me* to explain, my dear," said Mr. Donnithorne, interrupting his spouse. "You may not be aware, sir, that many of our miners are men of considerable mental ability, and some of them possess such power of speech, and so earnest a spirit, that the Wesleyan body have appointed them to the office of local preaching. They do not become ministers, however, nor are they liable to be sent out of the district like them. They don't give up their ordinary calling, but are appointed to preach in the various chapels of the district in which they reside, and thus we accomplish an amount of work which could not possibly be overtaken by the ordinary ministry."

"Indeed! but are they not untrained men, liable to teach erroneous doctrine?" asked Mr. Clearemout.

"They are not altogether untrained men," replied Mr. Donnithorne. "They are subjected to a searching examination, and must give full proof of their Christianity, knowledge, and ability before being appointed."

"And good excellent Christian men many of them are," observed Mrs. Donnithorne, with much fervour

"Quite true," said her husband. "This James Penrose is one of our best local preachers, and sometimes officiates in our principal chapel. I confess, however, that those who have the management of this matter are not always very judicious in their appointments. Some of our young men are sorely tempted to show off their acquirements, and preach *themselves* instead of the gospel, and there are one or two whom I could mention, whose hearts are all right, but whose brains are so muddled and empty that they are utterly unfit to teach their fellows. We must not, however, look for perfection in this world, Mr. Clearemout. A little chaff will always remain among the wheat. There is no system without some imperfection, and I am convinced that upon the whole our system of appointing local preachers is a first-rate one. At all events it works well, which is one of the best proofs of its excellence."

"Perhaps so," said Mr. Clearemout, with the air of a man who did not choose to express an opinion on the subject; "nevertheless I had rather have a man who was *not* a local preacher."

"You can see and hear him, and judge for yourself," said Mr. Donnithorne; "for he is, I believe, to preach in our chapel to-morrow, and if you will accept of a seat in our pew it will afford my wife and myself much—"

"Thank you," interrupted Mr. Clearemout; "I shall be very glad to take advantage of your kind offer. Service, you say, begins at—"

"Ten precisely," said Mr. Donnithorne.

CHAPTER XXV.

SHOWS THE MINER IN HIS SUNDAY GARB, AND ASTONISHES CLEAREMONT, BESIDES RELATING SOME INCIDENTS OF AN ACCIDENT.

THE sun rose bright and hot on Sunday morning, but the little birds were up before the great luminary, singing their morning hymn with noisy delight. It was a peaceful day. The wind was at rest, and the sea was calm. In the ancient town of St. Just it was peculiarly peaceful, for the numerous and untiring "stamps,"—which all the week had continued their clang and clatter, morning, noon, and night, without intermission—found rest on that hallowed day, and the great engines ceased to bow their massive heads, with the exception of those that worked the pumps. Even these, however, were required to do as little work as was compatible with the due drainage of the mines, and as their huge pulsations were intermittent—few and far between—they did not succeed in disturbing the universal serenity of the morning.

If there are in this country men who, more than any other, need repose, we should say they are the miners of Cornwall, for their week's work is exhausting far beyond that of most other labourers in the kingdom. Perhaps the herculean men employed in malleable-iron works toil as severely, but, besides the cheering consciousness of being well paid for their labour, these men exert their powers in the midst of sunlight and fresh air, while the miners toil in bad air, and get little pay in hard times. Sunday is indeed to them the Sabbath-day—it is literally what that word signifies, a day of much-required rest for body, soul, and spirit.

Pity that the good old word which God gave us is not more universally used among Christians! Would it not have been better that the translation Rest-day had been adopted, so that even ignorant men might have understood its true signification, than that we should have saddled it with a heathen name, to be an apple of discord in all generations? However, Sunday it is, so Sunday it will stand, we suppose, as long as the world lasts. After all, despite its faulty origin, that word is invested with old and hallowed associations in the minds of many, so we enter our protest against the folly of our forefathers very humbly, beseeching those who are prone to become nettled on this subject to excuse our audacity!

Well, as we have said, the Sunday morning to which we refer was peaceful; so would have been

Maggot's household had Maggot's youngest baby never been born; but, having been born, that robust cherub asserted his right to freedom of action more violently than ever did the most rabid Radical or tyrannical Tory. He "swarmed" about the house, and kicked and yelled his uttermost, to the great distress of poor little Grace, whose anxiety to get him ready for chapel was gradually becoming feverish. But baby Maggot had as much objection to go to chapel as his wicked father, who was at that time enjoying a pipe on the cliffs, and intended to leave his family to the escort of David Trevarrow. Fortunately, baby gave in about half-past nine, so that little Grace had him washed and dressed, and on his way to chapel in pretty good time, all things considered.

No one who entered the Wesleyan Chapel of St. Just that morning for the first time could have imagined that a large proportion of the well-dressed people who filled the pews were miners and bal-maidens. Some of the latter were elegantly—we might almost say gorgeously—attired, insomuch that, but for their hands and speech, they might almost have passed for ladies of fashion. The very latest thing in bonnets, and the newest mantles, were to be seen on their pretty heads and shapely shoulders.

As we have said before, and now repeat, this circumstance arose from the frequency of the visits of the individual styled "Johnny Fortnight," whose great aim and end in life is to supply miners—chiefly the females among them—with the necessaries, and unnecessaries, of wearing apparel.

When the managing director entered Mr. Donnithorne's pew and sat down beside his buxom hostess, he felt, but of course was much too well-bred to express, astonishment; for his host had told him that a large number of the people who attended the chapel were miners, and for a time he failed to see any of the class whom he had hitherto been accustomed to associate with rusty-red and torn garbs, and dirty hands and faces. But he soon observed that many of the stalwart, serious-looking men with black coats and white linen, had strong muscular hands, with hard-looking knuckles, which, in some instances, exhibited old or recent cuts and bruises.

It was a new sight for the managing director to behold the large, and apparently well-off families filing into the pews, for, to say truth, Mr. Clearemont was not much in the habit of attending church, and he had never before entered a Methodist chapel. He watched with much curiosity the gradual filling of the seats, and the grave, quiet demeanour of the people. Especially interesting was it when Maggot's family came in and sat down, with the baby Maggot in charge of little Grace. Mr. Clearemont had met

Maggot, and had seen his family; but interest gave place to astonishment when Mrs. Penrose walked into the church, backed by her sixteen children, the eldest males among whom were miners, and the eldest females tin-dressers, while the little males and females aspired to be miners and tin-dressers in the course of time.

"That's Penrose's family," whispered Mr. Donnithorne to his guest.

"What! the local's family?"

Mr. Donnithorne nodded.

Soon after, a tall, gentlemanly man ascended the pulpit.

The managing director was disappointed. He had come there to hear a miner preach, and behold, a clergyman!

"Who is he?" inquired Clearemout.

But Mr. Donnithorne did not answer. He was looking up the hymn for Mrs. D., who, being short-sighted, claimed exemption from the duty of "looking up" anything. Besides, he was a kind, good man at heart—though rather fond of smuggling, and given to the bottle, according to Oliver Trembath's account of him—and liked to pay his wife little attentions.

But there were still greater novelties in store for the London man that morning. It was new to him to hear John Wesley's beautiful hymns sung to equally beautiful tunes, which were not, however, unfamiliar to his ear, and sung with a degree of fervour that quite drowned his own voice, powerful and deep though it was. It was a new and impressive thing to hear the thrilling, earnest tones of the preacher as he offered up an eloquent extempore prayer,—to the petitions in which many of the people in the congregation gave utterance at times to startlingly fervent and loud responses—not in set phraseology, but in words that were called forth by the nature of each petition, such as "Glory to God," "Amen," "Thanks be to Him,"—showing that the worshippers followed and sympathized with their spokesman, thus making his prayer their own. But the newest thing of all was to hear the preacher deliver an eloquent, earnest, able, and well-digested sermon, without book or note, in the same natural tone of voice with which a man might address his fellow in the street—a style of address which riveted the attention of the hearers, induced them to expect that he had really something important to say to them, and that he thoroughly believed in the truth of what he said.

"A powerful man," observed the managing director as they went out; "your clergyman, I suppose?"

"No, sir," replied Mr. Donnithorne with a chuckle, "our minister is preaching elsewhere to-day. That was James Penrose."

"What: the miner?" exclaimed Clearemout in astonishment.

"Ay, the local preacher too."

"Why, the man spoke like Demosthenes, and quoted Bacon, Locke, Milton, and I know not who all—you amaze me," said Mr. Clearemout. "Surely all your local preachers are not equal to this one."

"Alas, no! some of the young ones are indeed able enough to spout poetry and quote old authors, and too fond they are of doing so; nevertheless, as I have said to you before, most of the local preachers are sober-minded, sterling Christian men, and a few of them have eminent capabilities. Had Penrose been a younger man he would probably have entered the ministry, but being above forty, with an uncommonly large family, he thinks it his duty to remain as he is, and do as much good as he can."

"But surely he might find employment better suited to his talents?" said Clearemout.

"There is not much scope in St. Just," replied Mr. Donnithorne, with a smile, "and it is a serious thing for a man in his circumstances to change his abode and vocation. No, no, I think he is right to remain a miner."

"Well, I confess that I admire his talents," returned Clearemout, "but I still think that an ordinary miner would suit me better."

"Well, I know of one who will suit you admirably. He is common enough to look at, and if you will accompany me into the mine to-morrow I'll introduce you to him. I'm not fond of descending the ladders now-a-days, though I could do it very well when a youth, but as the man I speak of works in one of the levels near the surface, I'll be glad to go down with you, and Captain Dan shall lead us."

True to his word the old gentleman met Mr. Clearemout the following morning at nine o'clock, and accompanied him down into the mine.

Their descent was unmarked by anything particular at first. They wore the usual suit of underground clothing, and each carried a lighted candle attached to his hat. After descending about thirty fathoms they left the main shaft and traversed the windings of a level until they came to a place where the sound of voices and hammers indicated that the miners were working. In a few seconds they reached the end of the level.

Here two men were "driving" the level, and another—a very tall powerful man—was standing in a hole driven up slanting ways into the roof, and cutting the rock above his head. His attitude and aspect were extremely picturesque, standing as he did on a raised platform with his legs firmly planted, his muscular arms raised above him to cut the rock overhead, and the candle so placed as to cause his figure to appear almost black and unnaturally gigantic.

"Stay a minute, Captain Dan," said Mr. Donnithorne. "That, Mr. Clearemout, is the man I spoke of—what think you of his personal appearance?"

Clearemout did not reply for a few minutes, but stood silently watching the man as he continued to wield his heavy hammer with powerful strokes—delivering each with a species of gasp which indicated not exhaustion, but the stern vigour with which it was given.

"He'll do," said Clearemout in a decided tone.

"Hallo! James," shouted Mr. Donnithorne.

"Hallo! sir," answered the man, looking back over his shoulder.

"There's a gentleman here who wants to speak to you."

The miner flung down his tools, which clattered loudly on the hard rock, as he leaped from his perch with the agility of one whose muscles are all in full and constant exercise.

"What! not the local—."

Before the managing director could finish his sentence Mr. Donnithorne introduced him to James Penrose, and left the two for a time to talk together.

It need scarcely be added that Clearemout was quite willing to avail himself of the services of the "local," but the local did not meet his proposals so readily as he would have wished. Penrose was a cautious man, and said he would call on Mr. Clearemout in the evening after he had had time to consider the matter.

With this reply the other was fain to rest satisfied, and shortly after, he returned to the bottom of the shaft with his friends, leaving the hardy miner to pursue his work.

At the bottom of the shaft they were accosted by a sturdy little man, who told them that a large piece of timber was being sent down the shaft, and it would be advisable to wait until it reached the bottom.

"Is it on the way, Spankey?" asked Captain Dan.

"Iss, sure, if it haven't walked into the thirty-fathom level in passin'."

Spankey was a humorous individual, addicted to joking.

"Are you married, Spankey?" asked Clearemout, looking down with a grin at the dirty little fellow beside him.

"Iss, sur. Had two wives, an' the third wan is waitin' for me, 'spose."

"Any children, Spankey?"

"Iss, six, countin' the wan that died before it could spaik."

At this point the beam was heard coming down. In a few seconds it made its appearance, and was hauled a little to one side by Spankey, who proceeded to unwind the chain that had supported it.

"I'll give 'em the signal, Captain Dan, to haul up the chain before thee do go on the ladders."

The signal was given accordingly, and the engine immediately began to draw up the chain by which the beam had been lowered.

This chain had a hook at one end of it, and, as ill-luck would have it, the hook caught Spankey by the right leg of his trousers, and whisked him off his feet. Almost before those beside him could conceive what had happened, the unfortunate man went up the shaft feet-foremost, with a succession of dreadful yells, in the midst of which could be heard a fearful rending of strong linen.

Fortunately for Spankey, his nether garments were not only strong, but new, so that when the rend came to the seam at the foot, it held on, else had that facetious miner come down the shaft much faster than he went up, and left his brains at the bottom as a memorial of the shocking event!

With palpitating hearts, Captain Dan, Clearemout, and old Donnithorne ran up the ladders as fast as they could. In a few minutes they reached the thirty-fathom level, and here, to their great relief, they found Spankey supported in the arms of stout George Tonkin.

That worthy, true to his promise to Oliver Trembath, had gone to work in Botallack Mine, and had that very day commenced operations in the thirty-fathom level referred to. Hearing the terrible screams of Spankey, he rushed to the end of the level just as the unfortunate man was passing it The risk was great, but Tonkin was accustomed to risks, and prompt to act. He flung his arms round Spankey, drew him forcibly into the level, and held on for life. There was a terrible rend; the leg of the trousers gave way at the hip, and went flapping up to grass, leaving the horrified miner behind.

" Not gone dead yet, sur, but goin' fast," was Spankey's pathetic reply to Captain Dan's anxious inquiries.

It was found, however, that, beyond the fright, the man had received no damage whatever.

The only other noteworthy fact in reference to this incident is, that when Captain Dan and his companions reached the surface, they were met by the lander, who, with a face as pale as a ghost, held up the torn garment. Great was this man's relief, and loud the fit of laughter with which he expressed it, when Spankey, issuing from the mouth of the shaft, presented his naked limb, and claimed the leg of his trousers !

CHAPTER XXVI.

TELLS OF A DISCOVERY AND A DISASTER.

THAT afternoon another accident occurred in the mine, which was of a much more serious nature than the one just recorded, and which interfered somewhat with the plans of the managing director of the Great Wheal Dooem Mining Company.

Not long after his interview with Clearemout, James Penrose finished a blast-hole, and called to Zackey Maggot to fetch the fuse.

Zackey had been working for a week past in connexion with Penrose, and, at the time he was called, was engaged in his wonted occupation of pounding "tamping" wherewith to fill the hole.

Wherever Zackey chanced to be at work, he always made himself as comfortable as circumstances would admit of. At the present time he had discovered a little hollow or recess in the wall of the level, which he had converted into a private chamber for the nonce.

There was a piece of flat rock on the floor of this recess, which Zackey used as his anvil, and in front of which he kneeled. At his side was a candle, stuck against the wall, where it poured a flood of light on objects in its immediate neighbourhood, and threw the boy's magnified shadow over the floor and against the opposite wall of the level. Above his head was a small shelf, which he had ingeniously fixed in a narrow part of the cell, and on this lay a few candles, a stone bottle of water, a blasting fuse, and part of his lunch, which he had been unable to consume, wrapped in a piece of paper. A small wooden box on the floor, and a couple of pick-hilts, leaning against the wall, completed the furniture of this subterranean grotto.

Zackey, besides being a searcher after metals, possessed an unusual amount of metal in himself. He was one of those earnest, hard-working, strong-hearted boys who pass into a state of full manhood, do the work of men, and are looked upon as being men, before they have passed out of their "teens." The boy's manhood, which was even at that early period of his life beginning to show itself, consisted not in his looks or his gait, although both were creditable, but in his firmness of purpose and force of character. What Zackey undertook to do he always did. He never left any work in a half-finished state, and he always employed time diligently.

In the mine he commenced to labour the moment he entered, and he never ceased, except during a short period for "kroust," until it was time to shoulder his tools, and mount to the regions of light. Aboveground, he was as ready to skylark as the most volatile of his companions, but underground he was a pattern of perseverance—a true Cornish miner in miniature. His energy of character was doubtless due to his reckless father, but his steadiness was the result of "Uncle Davy's" counsel and example.

"Are you coming, Zackey?" shouted Penrose, from the end of the level.

"Iss, I'm comin'," replied the boy, taking the fuse from the shelf, and hastening towards his companion.

Penrose had a peculiar and pleased expression on his countenance, which Zackey observed at once.

"What do 'ee grizzle like that for?" inquired the boy.

"I've come on a splendid bunch of copper, Zackey," replied the man; "you and I shall make money soon. Run away to your work, lad, and come back when you hear the shot go off."

Zackey expressed a hope that the prophecy might come true, and returned to his cell, where he continued pounding diligently—thinking the while of rich ore and a rapid fortune.

There was more reason in these thoughts than one might suppose, for Cornish miners experience variety of fortune. Sometimes a man will labour for weeks and months in unproductive ground, following up a small vein in the hope of its leading into a good lode, and making so little by his hard toil that on pay-day of each month he is compelled to ask his employer for "subsist"—or a small advance of money—to enable him to live and go on with his work. Often he is obliged to give up in despair, and change to a more promising part of the mine, or to go to another mine altogether; but, not unfrequently, he is rewarded for his perseverance by coming at last to a rich "lode," or mass, or "bunch" of copper or tin ore, out of which he will rend, in a single month, as much as will entitle him to thirty or forty, or even a hundred pounds, next pay-day.

Such pieces of good fortune are not of rare occurrence. Many of the substantial new cottages to be seen in St. Just at the present day have been built by miners who became suddenly fortunate in this way, so that, although the miner of Cornwall always works hard, and often suffers severe privation, he works on with a well-grounded expectation of a sudden burst of temporal sunshine in his otherwise hard lot.

Zackey Maggot was dreaming of some such gleam of good fortune, and patiently pounding away at the tamping, when he heard the explosion of the blast. At the same moment a loud cry rang through the underground caverns. It was one of those terrible, unmistakable cries, which chill the blood and thrill the hearts of those who hear them, telling of some awful catastrophe.

The boy leaped up and ran swiftly toward the end of the level, where he called to his companion, but received no answer. The smoke which filled the place was so dense that he could not see, and could scarcely breathe. He ran forward, however, and stumbled over the prostrate form of Penrose. Zackey guessed correctly what had occurred, for the accident was—and alas! still is—too common in the mines. The shot had apparently missed fire. Penrose had gone forward to examine it, and it exploded in his face.

To lift his companion was beyond Zackey's power, to leave him lying in such dense smoke for any length of time would, he knew, insure his suffocation, so he attempted to drag him away, but the man was too heavy for him. In his extremity the poor boy uttered a wild cry for help, but he shouted in vain, for there was no one else at work in the level. But Zackey was not the boy to give way to despair, or to act thoughtlessly, or in wild haste in this emergency. He suddenly recollected that there was a rope somewhere about the level. He sought for and found it. Fastening an end of it round the body of the man, under the arm-pits, he so arranged that the knot of the loop should reach a few inches beyond his head, and on this part of the loop he spread a coat, which thus formed a support to the head, and prevented it being dragged along the ground. While engaged in this operation the poor boy was well-nigh suffocated with smoke, and had to run back once to where the air was purer in order to catch a breath or two. Then, returning, he seized the rope, passed it over his shoulder, and bending forward with all his might and main dragged the man slowly but steadily along the floor of the level to a place where the air was comparatively pure.

Leaving him there he quickly fixed a candle in his hat, and carrying another in his hand, to avoid the risk of being left in darkness by an accidental stumble or gust of air, Zackey darted swiftly along the level and ran up the ladders at his utmost speed. Panting for breath, and with eyes almost starting from their sockets, he rushed into the engine-house, and told the man in charge what had occurred; then he dashed away to the counting-house and gave the alarm there, so that, in a very few minutes, a number of men descended the shaft and gathered round the prostrate miner. The doctor who had taken Oliver Trembath's place during his absence was soon in attendance, and found that although no bones had been broken, Penrose's face was sadly injured, how deep the injury extended could not at that time be ascertained, but he feared that his eyes had been altogether destroyed.

After the application of some cordial the unfortunate man began to revive, and the first words he uttered were, "Praise the Lord"—evidently in reference to his life having been spared.

"Is that you, Zackey?" he inquired after a few moments.

"No, it is the doctor, my man. Do you feel much pain in your head?" he asked as he knelt beside him.

"Not much; there is a stunned feeling about it, but little pain. You 'd better light a candle."

"There are candles burning round you," said the doctor. "Do you not see them? There is one close to your face at this moment."

Penrose made no answer on hearing this, but an expression of deep gravity seemed to settle on the blackened features.

"We must get him up as soon as possible," said the doctor, turning to Captain Dan, who stood at his elbow.

"We 're all ready, sir," replied the Captain, who had quietly procured ropes and a blanket, while the doctor was examining the wounds.

With great labour and difficulty the injured man was half hauled, half carried, and pushed up the shaft, and laid on the grass.

"Is the sun shining?" he asked in a low voice.

"Iss, it do shine right in thee face, Jim," said one of the miners, brushing away a tear with the back of his hand.

Again the gravity of Penrose's countenance appeared to deepen, but he uttered no other word; so they brought an old door and laid him on it. Six strong men raised it gently on their shoulders, and, with slow steps and downcast faces, they carried the wounded miner home.

CHAPTER XXVII.

INDICATES THAT "WE LITTLE KNOW WHAT GREAT THINGS FROM LITTLE THINGS MAY RISE."

SOON after this accident to James Penrose, the current of events at the mines was diverted from its course by several incidents, which, like the obstructing rocks in a rapid, created some eddies and whirlpools in the lives of those personages with whom this chronicle has to do.

As the beginning of a mighty inundation is ofttimes an insignificant-looking leak, and as the cause of a series of great events is not unfrequently a trifling incident, so the noteworthy circumstances which we have still to lay before our readers were brought about by a very small matter—by a baby—*the* baby Maggot!

One morning that cherubical creature opened its eyes at a much earlier hour than usual, and stared at the ceiling of its father's cottage. The sun was rising, and sent its unobstructed rays through the window of Maggot's cottage, where it danced on the ceiling as if its sole purpose in rising had been to amuse the Maggot baby. If so, it was pre-eminently successful in its attempts, for the baby lay and smiled for a long time in silent ecstasy.

Of course, we do not mean to say that the sun itself, or its direct rays, actually danced. No, it was too dignified a luminary for that, but its rays went straight at a small looking-glass which was suspended on the wall opposite to the window, and this being hung so as to slope forward, projected the rays obliquely into a tub of water which was destined for family washing purposes; and from its gently moving surface they were transmitted to the ceiling, where, as aforesaid, they danced, to the immense delight of Maggot junior.

The door of the cottage had been carelessly closed the previous night when the family retired to rest, and a chink of it was open, through which a light draught of summer air came in. This will account for the ripple on the water, which (as every observant reader will note) ought, according to the laws of gravitation, to have lain perfectly still.

The inconstancy of baby Maggot's nature was presently exhibited in his becoming tired of the sun, and the restlessness of his disposition displayed in his frantic efforts to get out of bed. Being boxed in with a board, this was not an easy matter, but the urchin's limbs were powerful, and he finally got over the obstruction sufficiently far to lose his balance, and fall with a sounding flop on the floor.

It is interesting to notice how soon deceit creeps into the hearts of some children! Of course the urchin fell sitting-wise—babies always do so, as surely as cats fall on their feet. In ordinary circumstances he would have intimated the painful mishap with a dreadful yell; but on this particular occasion young Maggot was bent on mischief. Of what sort, he probably had no idea, but there must have been a latent feeling of an intention to be "bad" in some way or other, because, on reaching the ground, he pursed his mouth, opened his eyes very wide, and looked cautiously round to make sure that the noise had awakened no one.

His father, he observed with a feeling of relief, was absent from home—not a matter of uncommon occurrence, for that worthy man's avocations often called him out at untimeous hours. Mrs. Maggot was in bed snoring, and wrinkling up her nose in consequence of a fly having perched itself obstinately on the point thereof. Zackey, with the red earth of the mine still streaking his manly countenance, was rolled up like a ball in his own bed in a dark recess of the room, and little Grace Maggot could be seen in the dim perspective of a closet, also sound asleep, in her own neat little bed, with her hair streaming over the pillow, and the "chet" reposing happily on her neck.

But that easily satisfied chet had long ago had more than enough of rest. Its repose was light, and the sound of baby Maggot falling out of bed caused it to rise, yawn, arch its back and tail, and prepare itself for the mingled joys and torments of the opening day. Observing that the urchin rose and staggered with a gleeful expression towards the door, the volatile chet made a dash at him sidewise, and gave him such a fright that he fell over the door-step into the road.

Again was that tender babe's deceitfulness of character displayed, for, instead of howling, as he would have done on other occasions, he exercised severe self-restraint, made light of a bruised shin, and, gathering himself up, made off as fast as his fat legs could carry him.

There was something deeply interesting—worthy of the study of a philosopher—in the subsequent actions of that precocious urchin. His powers in the way of walking were not much greater than those of a very tipsy man, and he swayed his arms about a good deal to maintain his balance, especially at the outset of the journey, when he imagined that he heard the maternal voice in anger and the maternal footsteps in pursuit in every puff of wind, grunt of pig, or bark of early-rising cur. His entire soul was engrossed in the one grand, vital, absorbing idea of escape! By degrees, as distance from the paternal roof increased, his fluttering spirit grew calmer and his gait more steady, and the flush of victory gathered on his brow and sparkled in his eye, as the conviction was pressed home upon him that, for the first time in his life, he was *free!* free as the wind of heaven to go where he pleased—to do what he liked—to be *as bad as possible*, without let or hindrance!

Not that baby Maggot had any stronger desire to be absolutely wicked than most other children of his years; but, having learnt from experience that the attempt to gratify any of his desires was usually checked and termed "bad," he naturally felt that a state of delight so intense as that to which he had at last attained, must necessarily be the very quintessence of iniquity. Being resolved to go through with it at all hazards, he felt proportionately wild and reckless. Such a state of commotion was there in his heaving bosom, owing to contradictory and conflicting elements, that he felt at one moment inclined to lie down and shout for joy, and the next, to sink into the earth with terror.

Time, which proverbially works wonderful changes, at length subdued the urchin to a condition of calm goodness and felicity, that would have rejoiced his mother's heart, had it only been brought on in ordinary circumstances at home.

There is a piece of waste ground lying between

St. Just and the sea,—a sort of common, covered with heath and furze—on which the ancient Britons have left their indelible mark, in the shape of pits and hollows and trenches, with their relative mounds and hillocks. Here, in the days of old, our worthy but illiterate forefathers had grubbed and dug and turned up every square foot of the soil, like a colony of gigantic rabbits, in order to supply the precious metal of the country to the Phœnicians, Jews, and Greeks.

The ground on this common is so riddled with holes of all sizes and shapes, utterly unguarded by any kind of fence, that it requires care on the part of the pedestrian who traverses the place even in daylight. Hence the mothers of St. Just are naturally anxious that the younger members of their families should not go near the common, and the younger members are as naturally anxious that they should visit it.

Thither, in the course of time—for it was not far distant,—the baby Maggot naturally trended; proceeding on the principle of "short stages and long rests." Never in his life—so he thought—had he seen such bright and beautiful flowers, such green grass, and such lovely yellow sand, as that which appeared here and there at the mouths of the holes and old shafts, or such a delicious balmy and sweet-scented breeze as that which came off the Atlantic and swept across the common. No wonder that his eyes drank in the beautiful sights, for they had seen little of earth hitherto, save the four walls of his father's cottage and the dead garden wall in front of it; no wonder that his nostrils dilated to receive the sweet odours, for they had up to that date lived upon air which had to cross a noisome and stagnant pool of filth before it entered his father's dwelling; and no wonder that his ears thrilled to hear the carol of the birds, for they had previously been accustomed chiefly to the voices of poultry and pigs, and to the caterwauling of the "chet."

But as every joy has its alloy, so our youthful traveller's feelings began to be modified by a gnawing sensation of hunger, as his usual hour for breakfast approached. Still he wandered on manfully, looking into various dark and deep holes with much interest and a good deal of awe. Some of the old shafts were so deep that no bottom could be seen; others were partially filled up, and varied from five to twenty feet in depth. Some were nearly perpendicular, others were sloped and irregular in form; but all were more or less fringed with gorse bushes in full bloom. In a few cases the old pits were concealed by these bushes.

It is almost unnecessary to say that baby Maggot's progress, on that eventful morn, was—unknown to himself—a series of narrow escapes from beginning to end—no, not exactly to the end, for his last adventure could scarcely be deemed an escape. He was standing on the edge of a hole, which was partially concealed by bushes. Endeavouring to peer into it he lost his balance and fell forward. His ready hands grasped the gorse and received innumerable punctures, which drew forth a loud cry Head-foremost he went in, and head-foremost he went down full ten feet, when a small bush caught him, and lowered him gently to the ground, but the spot on which he was landed was steep; it sloped towards the bottom of the hole, which turned inwards and became a sort of cavern. Struggling to regain his footing, he slipped and rolled violently to the bottom, where he lay for a few minutes either stunned or too much astonished to move. Then he recovered a little and began to whimper. After which he felt so much better that he arose and attempted to get out of the hole, but slipped and fell back again, whereupon he set up a hideous roar which continued without intermission for a quarter of an hour, when he fell sound asleep, and remained in happy unconsciousness for several hours.

Meanwhile the Maggot family was, as may well be believed, thrown into a state of tremendous agitation. Mrs. Maggot, on making the discovery that baby had succeeded in scaling the barricade, huddled on her garments and roused her progeny to assist in the search. At first she was not alarmed, believing that she should certainly find the self-willed urchin near the house, perhaps in the cottage of the Penroses. But when the cottages in the immediate neighbourhood had been called at, and all the known places of danger round the house examined, without success, the poor woman became frantic with terror, and roused the whole neighbourhood. Every place of possible and impossible concealment was searched, and at last the unhappy mother allowed the terrible thought to enter her mind that baby had actually accomplished the unheard-of feat of reaching the dreaded common, and was perhaps at that moment lying maimed or dead at the bottom of an ancient British shaft!

Immediately a body of volunteers, consisting of men, women, and children, and headed by Mrs. Maggot, hastened to the common to institute a thorough search; but they searched in vain, for the holes were innumerable, and the one in which the baby lay was well concealed by bushes. Besides, the search was somewhat wildly and hastily made, so that some spots were over-searched, while others were almost overlooked.

All that day did Mrs. Maggot and her friends wander to and fro over the common, and never, since the days when Phœnician galleys were moored by St. Michael's Mount, did the eyes of human beings pry so earnestly into these pits and holes. Had tin been their object, they could not have been more eager. Evening came, night drew on apace, and at last the forlorn mother sat down in the centre of a furze bush, and began to weep. But her friends comforted her. They urged her to go home and "'ave a dish o' tay" to strengthen her for the renewal of the search by torch-light. They assured her that the child could easily exist longer than a day without food, and they reminded her that her baby was an exceptional baby, a peculiar baby—like its father, uncommonly strong, and, like its mother, unusually obstinate. The latter sentiment, however, was *thought*, not expressed.

Under the influence of these assurances and persuasions, Mrs. Maggot went home, and, for a short time, the common was deserted.

Now it chanced, curiously enough, that at this identical point of time, Maggot senior was enjoying a pipe and a glass of grog in a celebrated kiddle-e-wink, with his friend George Tonkin. This kiddle-e-wink, or low public-house, was known as Un (or Aunt) Jilly's brandy-shop at Bosarne. It was a favourite resort of smugglers, and many a gallon of spirit, free of duty, had been consumed on the premises.

Maggot and his friend were alone in the house at the time, and their conversation had taken a dolorous turn, for many things had occurred of late to disturb the equanimity of the friends. Several ventures in the smuggling way had proved unsuccessful and the mines did not offer a tempting prospect just then. There had, no doubt, been one or two hopeful veins opened up, and some good "pitches" had been wrought, but these were only small successes, and the luck had not fallen to either of themselves. The recent discovery of a good bunch by poor Penrose had not been fully appreciated, for the wounded man had as yet said nothing about it, and little Zackey had either forgotten all about it in the excitement of the accident, or was keeping his own counsel.

Maggot talked gloomily about the advisability of emigration to America, as he sent clouds of tobacco-smoke up Un Jilly's chimney, and Tonkin said he would try the mines for a short time, and if things didn't improve he would go to sea. He did not, however, look at things in quite the same light with his friend. Perhaps he was of a more hopeful disposition, perhaps had met with fewer disappointments. At all events, he so wrought on Maggot's mind, that he half-induced him to deny his smuggling propensities for a time, and try legitimate work in the mines. Not that George Tonkin wanted to reform him by any means, but he was himself a little out of humour with his old profession, and sought to set his friend against it also.

"Try your luck in Botallack," said George Tonkin, knocking the ashes out of his pipe, preparatory to quitting the place, "that's my advice to 'ee, booy."

"I've half a mind to," replied Maggot, rising; "if that theere cargo I run on Saturday do go the way the last did, I'll ha' done with it, so I will. Good hevenin', Un Jilly."

"Good hevenin', an' don't 'ee go tumblin' down the owld shafts," said the worthy hostess, observing that her potent brandy had rendered the gait of the men unsteady.

They laughed as they received the caution, and walked together towards St. Just.

"Lev us go see if the toobs are all safe," said Maggot, on reaching the common.

Tonkin agreed, and they turned aside into a narrow track, which led across the waste-land where the search for the baby had been so diligently carried on all that day.

Night had set in, as we have said, and the searchers had gone up to the town to partake of much-needed refreshment, and obtain torches, so that the place was bleak and silent, as well as dark, when the friends crossed it, but they knew every foot of the ground so thoroughly, that there was no fear of their stumbling into old holes. Maggot led the way, and he walked straight to the old shaft where his hopeful son lay.

There were three noteworthy points of coincidence here to which we would draw attention. It was just because this old shaft was so well concealed that Maggot had chosen it as a place in which to hide his tubs of smuggled brandy; it was owing to the same reason that the town's-people had failed to discover it while searching for the baby, and it was —at least we think it must have been—just because of the same reason that baby Maggot had found it, for that amiable child had a peculiar talent—a sort of vocation—for ferreting out things and places hidden and secret, especially if forbidden.

Having succeeded in falling into the hole, the urchin naturally discovered his father's tubs. After crying himself to sleep as before mentioned, and again awakening, his curiosity in respect to these tubs afforded him amusement, and kept him quiet for a time; perhaps the fact that one of the tubs had leaked and filled the lower part of the old shaft with spirituous fumes, may account for the baby continuing to keep quiet, and falling into a sleep which lasted the greater part of the day; at all events, it is certain that he did not howl, as might have been expected of him in the circumstances. Towards evening, however, he began to move about among the tubs, and to sigh and whimper in a subdued way, for his stomach, unused to such prolonged fasting, felt very uncomfortable. When darkness came on baby Maggot became alarmed, but, just about the time of his father's approach, the moon shone out and cast a cheering ray down the shaft, which relieved his mind a little.

"George," said Maggot in a whisper, and with a serious look, "some one have bin here."

"D'ee think so?" said Tonkin.

"Iss I do; the bushes are broken a bit. Hush! what's that?"

The two men paused and looked at each other with awe depicted on their faces, while they listened intently, but, in the words of the touching old song, "the beating of their own hearts was all the sound they heard."

"It wor the wind," said Maggot.

"Iss, that's what it wor," replied Tonkin; "come, lev us go down. The wind can't do no harm to we."

But although he proposed to advance he did not move, and Maggot did not seem inclined to lead the way, for just then something like a sigh came from below, and a dark cloud passed over the moon.

It is no uncommon thing to find that men who are physically brave as lions become nervous as children when anything bordering on what they deem supernatural meets them. Maggot was about the most reckless man in the parish of St. Just, and Tonkin was not far behind him in the quality of courage, yet these two stood there with palpitating hearts undecided what to do.

Ashamed of being thought afraid of anything, Maggot at last cleared his throat, and, in a husky voice, said—

"Come then, lev us go down."

So saying he slid down the shaft, closely followed by Tonkin, who was nearly as much afraid to be left alone on the bleak moor as he was to enter the old mine.

Now, while the friends were consulting with palpitating hearts above, baby Maggot, wide awake and trembling with terror, listened with bated breath below, and when the two men came scrambling down the sides of the shaft his heart seemed to fill up his breast and throat, and his blood began to creep in his veins. Maggot could see nothing in the gloomy interior as he advanced, but baby could see his father's dark form clearly. Still, no sound escaped from him, for horror had bereft him of power. Just then the dark cloud passed off the moon, and a bright beam shone full on the upper half of the baby's face as he peeped over the edge of one of the tubs. Maggot saw two glaring eyeballs, and felt frozen alive instantly. Tonkin, looking over his comrade's shoulder, also saw the eyes, and was petrified on the spot. Suddenly baby Maggot found his voice and uttered a most awful yell. Maggot senior found his limbs, and turned to fly. So did Tonkin, but he slipped and fell at the first step. Maggot fell over him. Both rose and dashed up the shaft, scraping elbows, shins, and knuckles as they went, and, followed by a torrent of hideous cries, that sounded in their ears like the screaming of fiends, they gained the surface, and, without exchanging a word, fled in different directions on the wings of terror!

Maggot did not halt until he burst into his house, and flung himself into his own chair by the chimney corner, whence he gazed on what was calculated to alarm as well as to perplex him. This was the spectacle of his own wife taking tea in floods of tears, and being encouraged in her difficult task by Mrs. Penrose and a few sympathizing friends.

With some difficulty he got them to explain this mystery.

"What! baby gone lost?" he exclaimed, "where away?"

When it was told him what had occurred, Maggot's eyes gradually opened, and his lips gradually closed, until the latter produced a low whistle.

"I think that I do knaw where the cheeld is," he said; "come along, an' I 'll show un to 'ee."

So saying, the wily smith, assuming an air of importance and profound wisdom, arose and led his wife and her friends, with a large band of men who had prepared torches, straight to the old shaft. Going down, but sternly forbidding any one to follow, he speedily returned with the baby in his arms, to the surprise of all, and to the unutterable joy of the child's mother.

In one sense, however, the result was disastrous. Curious persons were there who could not rest until they had investigated the matter further, and the tubs were not only discovered, but carried off by those who had no title to them whatever! The misfortune created such a tumult of indignation in the breast of Maggot, that he was heard in his wrath to declare he " would have nothin' more to do with un, but would go into the bal the next settin' day."

This was the commencement of that series of events which, as we have stated at the beginning of this chapter, were brought about by that wonderful baby—the baby Maggot.

CHAPTER XXVIII.

DESCRIBES SETTING-DAY AT THE MINE, ETC.

THAT very evening, while Maggot was smoking his pipe by the fireside, his son Zackey referred to the bunch of copper which Penrose had discovered in the mine. After a short conversation, Maggot senior went to the wounded man to talk about it.

"'Twas a keenly lode, did 'ee say?" asked Maggot, after he had inquired as to the health of his friend.

"Yes, and as I shall not be able to work there again," said Penrose sadly, "I would advise you to try it. Zackey is entitled to get the benefit of the discovery, for he was with me at the time, and, but for his aid, dear boy, I should have been suffocated."

Maggot said no more on that occasion about the mine, being a man of few words, but, after conversing a short time with the wounded man, and ascertaining that no hope was held out to him of the recovery of his sight, he went his way to the forge to work and meditate.

Setting-day came—being the first Saturday in the month, and no work was done on that day at Botallack, for the men were all aboveground to have their "pitches" for the next month fixed, and to receive their wages—setting-day being also pay-day.

Some time before the business of the day commenced, the miners began to assemble in considerable numbers in the neighbourhood of the account house. Very different was their appearance on that occasion from the rusty-red fellows who were wont to toil in the dark chambers far down in the depths below the spot where they stood. Their underground dresses were laid aside, and they now appeared in the costume of well-off tradesmen. There was a free-and-easy swing about the movements of most of these men that must have been the result of their occupation, which brings every muscle of the body into play, and does not—as is too much the case in some trades—over-tax the powers of a certain set of muscles to the detriment of others.

Some there were, however, even among the young men, whose hollow cheeks and bloodless lips, accompanied with a short cough, told of evil resulting from bad air and frequent chills; while, on the other hand, a few old men were to be seen with bright eyes and ruddy cheeks which indicated constitutions of iron. Not a few were mere lads, whose broad shoulders and deep chests and resolute wills, enabled them to claim the title, and do the work, of men.

There were some among them, both young and old, who showed traces of having suffered in their dangerous employment. Several were minus an eye, and one or two were nearly blind, owing to blast-holes exploding in their faces. One man in particular, a tall and very powerful fellow, had a visage which was quite blue, and one of his eyes was closed —the blue colour resulting from unburnt grains of powder having been blown into his flesh. He had been tattooed, in fact, by a summary and effective process. This man's family history was peculiar. His father, also a miner, had lived in a lonely cottage on a moor near St. Just, and worked in Baliswidden Mine. One night he was carried home and laid at his wife's feet, dead—almost dashed to pieces by a fall. Not long afterwards the son was carried to the same cottage with his right eye destroyed. Some time later a brother dislocated his foot twice within the year in the mine, and a few months after that another brother fell from a beam, descended about twenty-four feet perpendicularly, where he struck the side of the mine with his head, and had six or seven of his teeth knocked out; glancing off to one side he fell twenty feet more on the hard rock, where he was picked up insensible. This man recovered, however, under the careful nursing of his oft and sorely tried mother.

Maggot was present on this setting-day, with a new cap and a new blue cloth coat, looking altogether a surprisingly respectable character. A good deal of undertoned chaffing commenced when he appeared.

"Hallo!" exclaimed one, "goin' to become an honest man, Maggot?"

"Thinkin' 'bout it," replied the smith, with a good-humoured smile.

"Why, if I didn't knaw that the old wuman 's alive," said another, "I 'd say he was agoin' to get married again!"

"Never fear," exclaimed a third, "Maggot's far too 'cute a cunger to be caught twice."

"I say, my dear man," asked another, "have 'ee bin takin' a waalk 'pon the clifts lately?"

"Iss, aw iss," replied the smith with much gravity.

"Did 'ee find any more daws 'pon clift?" asked the other, with a leer.

There was a general laugh at this, but Maggot replied with good-humour—

"No, Billy, no—took 'em all away last time. But I 'm towld there 's some more eggs in the nest, so thee 'll have a chance some day, booy."

"I hope the daws ain't the worse of their ducking?" asked Billy with an expression of anxious interest.

"Aw, my dear," said Maggot, looking very sad, and shaking his head slowly, "didn't 'ee hear the noos?"

"No, not I."

"They did catch the noo complaint the doctor do spaik of—bronkeetis I think it is,—and although I did tie 'em up wi' flannel round their necks, an' water-gruel, besides 'ot bottles to their feet, they 're all gone dead. I mean to have 'em buried on Monday. Will 'ee come to the berryn, Billy?"

"P'raps I will," replied Billy, "but see that the grave-digger do berry 'em deep, else he 'll catch a blowin' up like the grave-digger did in Cambourne last week."

"What was that, booy? Let us hear about it, Billy," exclaimed several voices.

"Well, this is the way of it," said Billy: "the owld grave-digger in Cambourne was standin' about, after mittin' was over, a-readin' of the tomb-stones, for he 'd got a good edjication, had owld Tom. His name was Tom—the same man as put a straw-rope to the bell which the cows did eat away, so that he cudn't ring the people to mittin'. Well, when he was studdyin' the morials on the stones out comes Captain Rowe. He was wan o' the churchwardens, or somethin' o' that sort, but I don't knaw nothin' 'bout the church, so I ain't sure—an' he calls owld Tom into the vestry.

"'Now look here, Tom,' says the Captain very stern, 'they tell me thee 'rt gettin' lazy, Tom, an' that thee do dig the graves only four fut deep

Now, Tom, I was over to St. Just t' other day to a berryin', and I see that they do dig their graves six fut or more deeper than you do. That won't do, Tom, I tell 'ee. What's the meanin' of it?'

"This came somewhat suddent on owld Tom, but he wor noways put out.

"'Well, you do see, Cap'n Rowe,' says he, 'I do do it a-purpose, for I do look at the thing in two lights.'

"'How so?' asked the Captain.

"'Why, the people of St. Just only think of the berryin', but *I* do think of the resurrection; the consekince is that they do dig too deep, an' afore the St. Just folk are well out of their graves, *ours* will be a braave way up to heaven!'"

The laugh with which this anecdote was received had scarcely subsided when the upper half of one of the account-house windows opened, and the fine-looking head and shoulders of old Mr. Cornish appeared.

The manager laid an open book on the window-sill, and from this elevated position, as from a pulpit, he read out the names, positions, etc., of the various "pitches" that were to be "sett" for the following month. One of the mine captains stood at his elbow to give any required information—he and his three brother-captains being the men who had gone all over the mine during the previous month, examined the work, measured what had been done by each man or "pare" of men, knew the capabilities of all the miners, and fixed the portion that ought to be offered to each for acceptance or refusal.

The men assembled in a cluster round the window, and looked up while Mr. Cornish read off as follows:

"John Thomas's pitch at back of the hundred and five. By two men. To extend from the end of tram-hole, four fathom west, and from back of level, five fathom above."

For the enlightenment of the reader, we may paraphrase the above sentence thus:—

"The pitch or portion of rock wrought last month by John Thomas is now offered anew—in the first place, to John Thomas himself if he chooses to continue working it at our rate of pay, or, if he declines, to any other man who pleases to offer for it. The pitch is in the back (or roof) of the level, which lies one hundred and five fathoms deep. It must be wrought by two men, and must be excavated lengthwise to an extent of four fathoms in a westerly direction from a spot called the tram-hole. In an upward direction, it may be excavated from the roof of the level to an extent of five fathoms."

John Thomas, being present, at once offered "ten shillings," by which he meant that, knowing the labour to be undergone, and the probable value of the ore that would have to be excavated, he thought it worth while to continue at that piece of work, or that "pitch," if the manager would give him ten shillings for every twenty shillings' worth of mineral sent to the surface by him; but the captain also knew the ground and the labour that would be required, and his estimate was that eight shillings would be quite sufficient remuneration, a fact which was announced by Mr. Cornish simply uttering the words, "At eight shillings."

"Put her down, s'pose," said John Thomas after a moment's consideration.

Perhaps John knew that eight shillings was really sufficient, although he wanted ten. At all events he knew that it was against rules to dispute the point at that time, as it delayed business; that if he did not accept the offer, another man might do so; and that he might not get so good a pitch if he were to change.

The pitch was therefore sett to John Thomas, and another read off—

"Jim Hocking's pitch at back of the hundred and ten. By one man. To extend," etc.

"Won't have nothin' to do with her," said Jim Hocking.

Jim had evidently found the work too hard, and was dissatisfied with the remuneration, so he declined, resolving to try his chance in a more promising part of the mine.

"Will any one offer for this pitch?" inquired Mr. Cornish.

Eight and six shillings were sums immediately named by men who thought the pitch looked more promising than Jim did.

"Any one offer more for this pitch?" asked the manager, taking up a pebble from a little pile that lay at his elbow, and casting it into the air.

While that pebble was in its flight, any one might offer for the pitch, but the instant it touched the ground, the bargain was held to be concluded with the last bidder.

A man named Oats, who had been in a hesitating state of mind, here exclaimed "Five shillings" (that is, offered to work the pitch for five shillings on every twenty shillings' worth sent to grass); next instant the stone fell, and the pitch was sett to Oats.

Poor James Penrose's pitch was the next sett.

"James Penrose's *late* pitch," read the manager, giving the details of it in terms somewhat similar to these already sett, and stating that the required "pare," or force to be put on it, was two men and a boy.

"Put me down for it," said Maggot.

"Have you got your pare?" asked Mr. Cornish.

"Iss, sur."

"Their names?"

"David Trevarrow and my son Zackey."

The pitch was allocated in due form at the rate of fifteen shillings per twenty shillings' worth of mineral sent up—this large sum being given because it was not known to be an unusually good pitch, Penrose having been too ill to speak of his discovery since his accident, and the captain having failed to notice it. When a place is poor-looking, a higher sum is given to the miner to induce him to work it. When it is rich, a lower sum is given, because he can make more out of it.

Thus the work went on, the sums named varying according to the nature of the ground, and each man saying "Naw," or "Put me down," or "That won't do," or "I won't have her," according to circumstances.

While this was going on at the window, another and perhaps more interesting scene was taking place in the office. This apartment presented a singular appearance. There was a large table in the centre of it, which, with every available inch of surface on a side-table, and on a board at the window, was completely covered with bank-notes and piles of gold, silver, and copper. Each pile was placed on a little square piece of paper containing the account-current for the month of the man or men to whom it belonged. Very few men laboured singly. Many worked in couples, and some in bands of three, five, or more. So much hard cash gave the place a wealthy appearance, and in truth there was a goodly sum spread out, amounting to several hundreds of pounds.

The piles varied very much in size, and conveyed a rough outline of the financial history of the men they belonged to. Some large heaps of silver, with a few coppers and a pile of sovereigns more than an inch high, lying on two or more five-pound notes indicated successful labour. Nevertheless, the evidence was not absolutely conclusive, because the large piles had in most cases to be divided between several men who had banded together; but the little square account-papers, with a couple of crowns on them, told of hard work and little pay, while yonder square with two shillings in the centre of it, betokened utter failure, only to be excelled by another square, on which lay *nothing!*

You will probably exclaim in your heart, reader, "What! do miners sometimes work for a month, and receive only two shillings, or *nothing* as wages?"

Ay, sometimes; but it is their own seeking if they do; it is not forced upon them.

There are three classes of miners—those who work on the surface, dressing ore, etc., who are paid a weekly wage; those who work on "tribute," and those who work at "tut-work." Of the first we say nothing, except that they consist chiefly of bal-maidens and children,—the former receiving about 18s. a month, and the latter from 8s. to 20s., according to age and capacity.

In regard to "tributers" and "tut-workers," we may remark that the work of both is identical in one respect—namely, that of hewing, picking, boring, and blasting the hard rock. In this matter they share equal toils and dangers, but they are not subjected to the same remunerative vicissitudes.

When a man works on "tribute" he receives so many shillings for every twenty shillings' worth of ore that he raises during the month, as already explained. If his "pitch" turns out to be rich in ore, his earnings are proportionably high; if it be poor, he remains poor also. Sometimes a part of the mineral lode becomes so poor that it will not pay for working, and has to be abandoned. So little as a shilling may be the result of a "tributer's" work for a month at one time, while at another time he may get a good pitch, and make £100 or £200 in the same period.

The "tutman" (or piece-work man), on the other hand, cuts out the rock at so much per fathom, and obtains wages at the rate of from £2, 10s. to £3 a month. He can never hope to make a fortune, but so long as health and strength last, he may count on steady work and wage. Of course there is a great deal of the work in a mine which is not directly remunerative, such as "sinking" shafts, opening up and "driving" (or lengthening) levels, and sinking "winzes." On such work tutmen are employed.

The man who works on "tribute" is a speculator. He who chooses "tut-work" is a steady labourer. The tributer experiences all the excitement of uncertainty, and enjoys the pleasures of hope. He knows something, too, about "hope deferred;" also can tell of hope disappointed; has his wits sharpened, and, generally, is a smart fellow. The tut-worker knows nothing of this, his pay being safe and regular, though small. Many quiet-going, plodding men prefer and stick to tut-work.

In and about the counting-room the men who had settled the matter of their next month's work were assembled. These—the cashier having previously made all ready—were paid in a prompt and business-like manner.

First, there came forward a middle-aged man. It was scarcely necessary for him to speak, for the cashier knew every man on the mine by name, and also how much was due to him, and the hundreds of little square accounts-current were so arranged that he could lay his hands on any one in an instant. Nevertheless, being a hearty and amiable man, he generally had a word to say to every one.

"How 's your son, Matthew?" he inquired of the middle-aged man, putting the square paper with its contents into his hand.

"He's braave, sir. The doctor do say he'll be about again in a week."

Matthew crumpled up his account-current,—notes, gold, silver, copper and all,—in his huge brown hand, and, thrusting the whole into his breeches pocket, said "Thank 'ee," and walked away.

Next, there came forward a young man with one eye, an explosion having shut up the other one for ever. He received his money along with that of the three men who worked in the same "pare" with him. He crumpled it up in the same reckless way as Matthew had done, also thrust it into his pocket, and walked off with an independent swagger. Truly, in the sweat, not only of his brow, but, of every pore in his body, had he earned it, and he was entitled to swagger a little just then. There was little enough room or inducement to do so down in the mine! After this young man a little boy came forward saying that his "faither" had sent him for his money.

It was observable that the boys and lads among those who presented themselves in the counting-room, were, as a rule, hearty and hopeful. With them it was as with the young in all walks of life. Everything looked bright and promising. The young men were stern, yet free-and-easy—as though they had already found life a pretty tough battle, but felt quite equal to it. And so they were, every one of them! With tough sinews, hard muscles, and indomitable energy, they were assuredly equal to any work that man could undertake; and many of them, having the fear of God in their hearts, were fitted to endure manfully the trials of life as well. The elderly men were sedate, and had careworn faces; they knew what it was to suffer. Many of them had carried little ones to the grave; they had often seen strong men like themselves go forth in the morning hale and hearty, and be carried to their homes at evening with blinded eyes or shattered limbs. Life had lost its gloss to them, but it had not lost its charms. There were loving hearts to work for, and a glorious end for which to live, or, if need be, to die—so, although their countenances were sedate they were not sad. The old men—of whom there were but two or three—were jolly old souls. They seemed to have successfully defied the tear-and-wear of life, to have out-lived its sorrows, and renewed their youth. Certainly they had not reached their second childhood, for they stepped forth and held out their hands for their pay as steadily as the best of the young ones.

When about one-half of the number had been paid, a woman in widow's weeds came forward to take up the pay due to her son—her "wretched Harry," as she styled him. All that was due was seven and sixpence. It was inexpressibly sad to see her retire with this small sum—the last that her unsettled boy was entitled to draw from the mines. He had worked previously in the neighbouring mine, Wheal Owles, and had gone to Botallack the month before. He was now off to sea, leaving his mother, who to some extent depended on him, to look out for herself.

The next who came forward was a blind man. He had worked long in the mine—so long that he could find his way through the labyrinth of levels as easily in his blind state as he did formerly with his eyesight. When his eyes were destroyed (in the usual way, by the explosion of a hole), he was only off work during the period of convalescence. Afterwards he returned to his familiar haunts underground; and although he could no longer labour in the old way, he was quite able to work a windlass, and draw up the bucket at a winze. For this he now pocketed two pounds sterling, and walked off as vigorously as if he had possessed both his eyes!

Among others, a wife appeared to claim her husband's pay, and she was followed by Zackey Maggot, who came to receive his own and Penrose's money.

"How does Penrose get on?" inquired the cashier, as he handed over the sum due.

"Slowly, sur," said Zackey.

"It is a bad case," said one of the captains, who sat close by; "the doctor thinks there is little or no chance for his eyesight."

Poor Zackey received his pay and retired without any demonstration of his wonted buoyancy of spirit, for he was fond of Penrose, almost as much so as he was of uncle David Trevarrow.

The varied fortune experienced in the mine was exhibited in one or two instances on this occasion. One man and a boy, working together, had, in their own phraseology, "got a sturt"—they had come unexpectedly on a piece of rich ground, which yielded so much tin that at the end of the month they received £25 between them. The man had been receiving "subsist," that is, drawing advances monthly for nearly a year, and, having a wife and children to support, had almost lost heart. It was said that he had even contemplated suicide, but this little piece of good fortune enabled him to pay off his debt and left something over. Another man and boy had £20 to receive. On the other hand, one man had only 2s. due to him, while a couple of men who had worked in poor ground found themselves 2s. in debt, and had to ask for "subsist."

Some time previous to this, two men had discovered a "bunch of copper," and in the course of two months they cleared £260. At a later period a man in Levant Mine, who was one of the Wesleyan local preachers, cleared £200 within a year. He gave a hundred pounds to his mother, and with the other hundred went off to seek his fortune in Australia!

After all the men had been paid, those who wished for "subsist," or advances, were desired to come forward. About a dozen of them did so, and among these were representatives of all classes—the diligent and strong, the old and feeble, and the young. Of course, in mining operations as in other work, the weak, lazy, and idle will ever be up to the lips in trouble, and in need of help. But in mining the best of men may be obliged to demand assistance, because, when tributers work on hopefully day after day and week after week on bad ground, they must have advances to enable them to persevere—not being able to subsist on air! This is no hardship, the mine being at all times open to their inspection, and they are allowed to select their own ground. Hence the demand for "subsist" is not necessarily a sign of absolute but only of temporary poverty. The managers make large or small advances according to their knowledge of the men.

There was a good deal of chaffing at this point in the proceedings—the lazy men giving occasion for a slight administration of rebuke, and the able men affording scope for good-humoured pleasantry and badinage.

In Botallack, at the present time, about forty or fifty men per month find it necessary to ask for "subsist."

Before the wages were paid, several small deductions had to be made. First, there was sixpence to be deducted from each man for "the club." This club consisted of those who chose to pay sixpence a month to a fund for the temporary support of those who were damaged by accidents in the mine. A similar sum per month was deducted from each man for "the doctor," who was bound, in consideration of this, to attend the miners free of charge. In addition to this a shilling was deducted from each man, to be given to the widow and family of a comrade who had died that month. At the present time from £18 to £20 are raised in this way when a death occurs, to be given to the friends of the deceased. It should be remarked that these deductions are made with the consent of the men. Any one may refuse to give to those objects, but, if he do so, he or his will lose the benefit in the event of his disablement or death.

Men who are totally disabled receive a pension from the club fund. Not long ago a miner, blind of one eye, left another mine and engaged in Botallack. Before his first month was out he exploded a blast-hole in his face, which destroyed the other eye. From that day he received a pension of £1 a month, which will continue till his death—or, at least as long as Botallack shall flourish,—and that miner may be seen daily, at the present time, going through the streets of St. Just with his little daughter, in a cart, shouting "Pilchards, fresh pilcha-a-rds, breem, pullock, fresh pullock, pil-*cha-a-rds*"—at the top of his stentorian voice—a living example of the value of "the club," and of the principle of insurance!

At length the business of the day came to a close. The wages were paid, the men's work for another month was fixed, the cases of difficulty and distress were heard and alleviated, and then the managers and agents wound up the day by dining together in the account-house, the most noteworthy point in the event being the fact that the dinner was eaten off plates made of pure Botallack tin.

Once a quarter this dinner, styled the "account dinner," is partaken of by any of the shareholders who may wish to be present, on which occasion the manager and agents lay before the company the condition and prospects of the mine, and a quarterly dividend (if any) is paid. There is a matter-of-fact and Spartan-like air about this feast which commands respect. The room in which it is held is uncarpeted, and its walls are graced by no higher works of art than the plans and sections of the mine. The food is excellent and substantial, but simple. There is abundance of it, but there are no courses—either preliminary or successive—no soup or fish to annoy one who wants meat; no ridiculous *entremêts* to tantalize one who wants something solid; no puddings, pies, or tarts to tempt men to gluttony. All set to work at the same time, and enjoy their meal *together*, which is more than can be said of most dinners. All is grandly simple, like the celebrated mine on which the whole is founded.

But there is one luxury at this feast which it would be unpardonable not to mention, namely, the punch. Whoever tastes this beverage can never forget it! Description were useless to convey an idea of it. Imagination were impotent to form a conception of it. Taste alone will avail, so that our readers must either go to Cornwall to drink it, or for ever remain unsatisfied. We can only remark, in reference to it, that it is potent as well as pleasant, and that it is also dangerous, being of an insinuating nature, so that those who partake freely have a tendency to wish for more, and are apt to dream (not unreasonably, but too wildly) of Botallack tin being transformed into silver and gold.

CHAPTER XXIX.

DETAILS, AMONG OTHER THINGS, A DEED OF HEROISM.

To work went Maggot and Trevarrow and Zackey on their new pitch next day like true Britons. Indeed, we question whether true Britons of the ancient time ever did go to work with half the energy or perseverance of the men of the present day. Those men of old were mere grubbers on the surface. They knew nothing of deep levels under the ocean. However, to do them justice, they made wonderfully extensive tunnels in mother earth, with implements much inferior to those now in use.

But, be that as it may, our trio went to work "with a will." Maggot was keen to get up as much of the rich mineral as possible during the month—knowing that he would not get the place next month on such good terms. Trevarrow, besides having no objections to make money when he could for its own sake, was anxious to have a little to spare to James Penrose, whose large family found it pinching work to subsist on the poor fellow's allowance from the club. As to Zackey, he was ready for anything where uncle Davy was leader. So these three resolved to work night and day. Maggot took his turn in the day-time and slept at night; Trevarrow slept in the day-time and worked at night; while the boy worked as long as he could at whatever time suited him best.

As they advanced on the lode it became larger and richer, and in a day or two it assumed such proportions as to throw the fortunate workers into a state of great excitement, and they tore out and blasted away the precious mineral like Titans.

One day, about kroust-time, having fired two holes, they came out of the "end" in which they wrought and sat down to lunch while the smoke was clearing away.

"'Tes a brave lode," said Maggot.

"It is," responded Trevarrow, taking a long draught of water from the canteen.

"What shall us do?" said Maggot, "go to grass to slaip, or slaip in the bal?"

"In the bal, if you do like it," said Trevarrow.

So it was agreed that the men should sleep in the mine on boards, or on any dry part of the level, in order to save the time and energy lost in ascending and descending the long ladders, and thus make the most of their opportunity. It was further resolved that Zackey should be sent up for dry clothes, and bring them their meals regularly. Trevarrow did not forget to have his Bible brought to him, for he was too serious a man to shut his eyes to the danger of a sudden run of good fortune, and thought that the best way to guard against evil would be to devote nearly all his short periods of leisure time to the reading of "the Word."

You may be sure that Maggot afterwards laughed at him for this, but he did not concern himself much about it at the time, because he was usually too hungry to talk at meal-times, and too sleepy to do so after work was over.

They were still busily discussing the matter of remaining in the mine all night, when they heard the kibble descending the shaft, near the bottom of which they sat, and next moment a man came to the ground with considerable violence.

"Why, Frankey, is that thee, booy?" said Maggot, starting up to assist him.

"Aw dear, iss; I'm gone dead a'most! aw dear! aw dear!"

"Why, whatever brought 'ee here?" said Trevarrow.

"The kibble, sure," replied the man, exhibiting his knuckles, which were cut and bleeding a good deal. "I did come by the chain anyhow."

This was indeed true. Frankey, as his mates called him, was at that time the "lander" in charge of the kibbles at the surface. It was his duty to receive each kibble as it was drawn up to the mouth of the shaft full of ore, empty it, and send it down again. Several coils of chain passing round the large drum of a great horse-windlass, called by the miners a "whim," was the means by which the kibbles were hoisted and lowered. The chain was so arranged that one kibble was lowered by it while the other was being drawn up. Frankey had emptied one of the kibbles, and had given the signal to the boy attending the horse to "lower away," when he inadvertently stepped into the shaft. With ready presence of mind the man caught the chain and clung to it, but the boy, being prevented by a pile of rubbish from seeing what had occurred, eased him down, supposing him to be the kibble!

This "easing down" a great number of fathoms was by no means an easy process, as those know well who have seen a pair of kibbles go banging up and down a shaft. It was all that poor Frankey could do to keep his head from being smashed against rocks and beams; but, by energetic use of arms and legs, he did so, and reached the bottom of the shaft without further damage than a little skin rubbed off his knees and elbows, and a few cuts on his hands. The man thought so little of it, indeed, that he at once returned to grass by the ladder-way, to the unutterable surprise and no little consternation of the boy who had "eased him down."

The air at the "end" of the level in which Maggot and Trevarrow worked was very bad, and, for some time past, men had been engaged in sinking a winze from the level above to connect the two, and send in a supply of fresh air by creating a new channel of circulation. This winze was almost completed, but one of the men employed at it had suddenly become unwell that day, and no other had been appointed to the work. As it was a matter of great importance to have fresh air, now that they had resolved to remain day and night in the mine for some time, Maggot and Trevarrow determined to complete the work, believing that one or two shots would do it. Accordingly, they mounted to the level above, and were lowered one at a time to the bottom of the unfinished winze by a windlass, which was turned by the man whose comrade had become unwell.

For nearly two hours they laboured diligently, scarce taking time to wipe the perspiration from their heated brows. At the end of that time the hole was sufficiently deep to blast, so Maggot called out—

"Zackey, my son, fetch the fuse and powder."

The boy was quickly lowered with these materials, and then drawn up.

Meanwhile Maggot proceeded to charge the hole, and his comrade sat down to rest. He put in the powder and tamping, and asked the other to hand him the tamping-bar.

"Zackey has forgot it," said Trevarrow, looking round.

"It don't matter; hand me the borer."

"No, I won't," said Trevarrow decidedly, as he grasped the iron tool in question. "Ho! Zackey, booy, throw down the tampin'-bar."

This was done, and the operation of filling the hole continued, while Trevarrow commented somewhat severely on his companion's recklessness.

"That's just how the most o' the reckless men in the bal do git blaw'd up," he said; "they're always picking away at the holes, and tamping with iron tools; why, thee might as well put a lighted match down the muzzle of a loaded gun as tamp with an iron borer."

"Come, now," said Maggot, looking up from his work with a leer, "it warn't that as made old Kimber nearly blow his-self up last week."

"No, but it was carelessness, anyhow," retorted Trevarrow; "and lucky for him that he was a smart man, else he'd bin gone dead by this time."

Maggot soon completed the filling of the hole, and then perpetrated as reckless a deed as any of his mining comrades had ever been guilty of. Trevarrow was preparing to ascend by the windlass, intending to leave his comrade to light the fuse and come up after him. Meanwhile Maggot found that the fuse was too long. He discovered this after it was fixed in the hole, and, unobserved by his companion, proceeded to cut it by means of an iron tool and a flat stone. Fire was struck at the last blow by the meeting of the iron and the stone, and the fuse ignited. To extinguish it was impossible; to cut it in the same way, without striking fire, was equally so. Of course there was plenty of time to ascend by the windlass, but *only one* at a time could do so. The men knew this, and looked at each other with terrible meaning in their eyes as they rushed at the bucket, and shouted to the man above to haul them up. He attempted to do so, but in vain. He had not strength to haul up two at once. One could escape, both could not, and to delay would be death to both. In this extremity David Trevarrow looked at his comrade, and said calmly—

"Escape, my brother; a minute more and I shall be in heaven."

He stepped back while he spoke—the bucket went rapidly upwards, and Trevarrow, sitting down in the bottom of the shaft, covered his eyes with a piece of rock and awaited the issue.

The rumbling explosion immediately followed, and the shaft was filled with smoke and flame and hurling stones. One of these latter, shooting upwards, struck and cut the ascending miner on his forehead as he looked down to observe the fate of his self-sacrificing comrade!

Maggot was saved, but he was of too bold and kindly a nature to remain for a moment inactive after the explosion was over. At once he descended, and, groping about among the *débris*, soon found his friend—alive, and almost unhurt! A mass of rock had arched him over—or rather, the hand of God, as if by miracle, had delivered the Christian miner.

After he was got up in safety to the level above they asked him why he had been so ready to give up his life to save his friend.

"Why," said David quietly, "I did think upon his wife and the child'n, and little Grace seemed to say to me 'Take care o' faither'—besides, there are none to weep if I was taken away, so the Lord gave me grace to do it."

That night there were glad and grateful hearts in Maggot's cottage—and never in this world was a more flat and emphatic contradiction given to any statement, than that which was given to David Trevarrow's assertion—"There are none to weep if I was taken away."[*]

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[*] A short but beautiful account of the above incident will be found in a little volume of poems, entitled *Lays from the Mine, the Moor, and the Mountain,* written by John Harris, a Cornish miner.

CHAPTER XXX.

REVEALS SOME ASTONISHING FACTS AND THEIR CONSEQUENCES.

Sorrow and trouble now began to descend upon Mr. Thomas Donnithorne like a thick cloud.

Reduced from a state of affluence to one bordering on absolute poverty, the old man's naturally buoyant spirit almost gave way, and it needed all the attentions and the cheering influence of his good wife and sweet Rose Ellis to keep him from going (as he often half-jestingly threatened) to the end of Cape Cornwall and jumping into the sea.

"It's all over with me, Oliver," said he one morning, after the return of his nephew from London. "A young fellow like you may face up against such difficulties, but what is an old man to do? I can't begin the world over again, and as for the shares I have in the various mines, they're not worth the paper they're writ upon."

"But things may take a turn," suggested Oliver; "this is not the first time the mines have been in a poor condition, and the price of tin low. When things get very bad they are likely to get better, you know. Even now there seems to be some talk among the miners of an improved state of things. I met Maggot yesterday, and he was boasting of having found a monstrous bunch, which, according to him, is to be the making of all our fortunes."

Mr. Donnithorne shook his head.

"Maggot's geese are always swans," he said; "no, no, Oliver, I have lost all hope of improvement. There are so many of these deceptive mines around us just now—some already gone down, and some going—that the public are losing confidence in us, and, somewhat unfairly, judging that, because a few among us are scoundrels, we are all a bad lot together."

"What do you think of Mr. Clearemout's new mine?" asked Oliver.

"I believe it to be a genuine one," said the old gentleman, turning a somewhat sharp glance on his nephew. "Why do you ask?"

"Because I doubt it," replied Oliver.

"You are too sceptical," said Mr. Donnithorne almost testily; "too much given to judging things at first sight."

"Nay, uncle, you are unfair. Had I judged of you at first sight, I should have thought you a—"

"Well, what? a smuggling old brandy-loving rascal—eh! and not far wrong after all."

"At all events," said Oliver, laughing, "I have lived to form a better opinion of you than that, but, in reference to Clearemout, I cannot shut my eyes to the fact that the work doing at the new mine is very like a sham, for they have only two men and a boy working her, with a captain to superintend, and it is said, for I made inquiries while in London, that thirty thousand pounds have been called up from the shareholders, and there are several highly paid directors, with an office-staff in the City drawing large salaries.

"Nonsense, Oliver," said Mr. Donnithorne more testily than before; "you know very well that things must have a beginning, and that caution is necessary at first in all speculations. Besides, I feel convinced that Mr. Clearemout is a most respectable man, and an uncommonly clever fellow to boot. It is quite plain that you don't like him—that's what prejudices you, Oliver. You're jealous of the impression he has made on the people here."

This last remark was made jestingly, but it caused the young doctor to wince, having hit nearer the truth than the old gentleman had any idea of, for, although Oliver envied not the handsome stranger's popularity, he was, almost unknown to himself, very jealous of the impression he seemed to have made on Rose Ellis.

A feeling of shame induced him to change the subject of conversation, with a laughing observation that he hoped such an unworthy motive did not influence him.

Now, while this conversation was going on in the parlour of Mr. Donnithorne's cottage, another dialogue was taking place in a small wooden erection at the end of the garden, which bore the dignified name of Rose's Bower. The parties concerned in it were George Augustus Clearemout and Rose Ellis.

A day or two previous to the conversation to which we are about to draw attention, the managing director had undergone a change in his sentiments and intentions. When he first saw Rose he thought her an uncommonly sweet and pretty girl. A short acquaintance with her convinced him that she was even sweeter and prettier than at first he had thought her. This, coupled with the discovery that her uncle was very rich, and that he meant to leave a large portion of his wealth, if not all of it, to Rose, decided Clearemout, and he resolved to marry her. Afterwards he became aware of the fact that old Mr. Donnithorne had met with losses, but he was ignorant of their extent, and still deemed it worth while to carry out his intentions.

George Augustus had been a "managing director" in various ways from his earliest infancy, and had never experienced much opposition to his will, so that he had acquired a habit of settling in his own mind whatever he meant to do, and forthwith doing it. On this occasion he resolved to sacrifice himself to Rose, in consideration of her prospective fortune —cash being, of course, Mr. Clearemout's god.

Great then was the managing director's surprise, and astonishing the condition of his feelings, when, on venturing to express his wishes to Rose, he was kindly, but firmly, rejected! Mr. Clearemout was so thunderstruck—having construed the unsophisticated girl's candour and simplicity of manner into direct encouragement—that he could make no reply, but, with a profound bow, retired hastily from her presence, went to his lodgings, and sat down with his elbows on the table, and his face buried in his large hands, the fingers of which appeared to be crushing in his forehead, as if to stifle the thoughts that burned there. After sitting thus for half an hour he suddenly rose, with his face somewhat paler, and his lips a little more firmly compressed than usual.

It was an epoch in his existence. The man who had so often and so successfully deceived others had made the wonderful discovery that he had deceived himself. He had imagined that money was his sole object in wishing to marry Rose. He now discovered that love, or something like it, had so much to do with his wishes that he resolved to have her without money, and also without her consent.

Something within the man told him that Rose's refusal was an unalterable one. He did not think it worth while to waste time in a second attempt. His plans, though hastily formed, required a good deal of preliminary arrangement, so he commenced to carry them out with the single exclamation, "I'll do it!" accompanied with a blow from his heavy fist on the table, which, being a weak lodging-house one, was split from end to end. But the managing director had a soul above furniture at that moment. He hastily put on his hat and strode out of the house.

Making good use of a good horse, he paid sundry mysterious visits to various smuggling characters, to all of whom he was particularly agreeable and liberal in the bestowal of portions of the thirty thousand pounds with which a too confiding public had intrusted him. Among other places he went to a cottage on a moor between St. Just and Penzance, and had a confidential interview with a man named Hicks, who was noted for his capacity to adapt himself to circumstances (when well paid) without being troubled by conscientious scruples. This man had a son who had once suffered from a broken collar-bone, and whose ears were particularly sharp. He chanced to overhear the conversation at the interview referred to, and dutifully reported the same to his mother, who happened to be a great gossip, and knew much about the private affairs of nearly everybody living within six miles of her. The good woman resolved to make some use of her information, but Mr. Clearemout left the cottage in ignorance, of course, of her resolution.

Having transacted these little pieces of business, the managing director returned home, and, on the day following, sought, and, as we have seen, obtained, an interview with Rose Ellis in her bower.

Recollecting the subject of their last conversation, Rose blushed, as much with indignation as confusion, at being intruded upon, but Mr. Clearemout at once dispersed her angry feelings by assuring her in tones of deferential urbanity that he would not have presumed to intrude upon her but for the fact that he was about to quit Cornwall without delay, and he wished to talk with her for only a few minutes on business connected with Mr. Donnithorne.

There was something so manly and straightforward in his tone and manner that she could not choose but allow him to sit down beside her, although she did falter out something about the propriety of talking on her uncle's business affairs with Mr. Donnithorne himself.

"Your observation is most just," said Mr. Clearemout earnestly; "but you are aware that your uncle's nature is a delicate, sensitive one, and I feel that he would shrink from proposals coming from me, that he might listen to if made to him through you. I need not conceal from you, Miss Ellis, that I am acquainted with the losses which your uncle has recently sustained, and no one can appreciate more keenly than I do the harshness with which the world, in its ignorance of details, is apt to judge of the circumstances which brought about this sad state of things. I cannot help feeling deeply the kindness which has been shown me by Mr. Donnithorne during my residence here, and I would, if I could, show him some kindness in return."

Mr. Clearemout paused here a few moments as if to reflect. He resolved to assume that Mr. Donnithorne's losses were ruinous, little imagining that in this assumption he was so very near the truth! Rose felt grateful to him for the kind and delicate way in which he referred to her uncle's altered circumstances.

"Of course," continued the managing director, "I need not say to *you* that his independent spirit would never permit him to accept of assistance in the form which would be most immediately beneficial to him. Indeed, I could not bring myself to offer money even as a loan. But it happens that I have the power, just now, of disposing of the shares which he has taken in Wheal Dooem Mine at a very large profit; and as my hope of the success of that enterprise is very small, I—"

"Very small!" echoed Rose in surprise. "You astonish me, Mr. Clearemout. Did I not hear you, only a few nights ago, say that you had the utmost confidence in the success of your undertaking?"

"Most true," replied the managing director with a smile; "but in the world of business a few hours work wonderful changes, sometimes, in one's opinion of things—witness the vacillations and variations 'on 'Change'—if I may venture to allude before a lady to such an incomprehensible subject."

Rose felt her vigorous little spirit rise, and she was about to return a smart reply in defence of woman's intelligence even in business matters, but the recollection of the altered relative position in which they now stood restrained her.

"Yes," continued Mr. Clearemout, with a sigh, "the confidence which I felt in Wheal Dooem has been much shaken of late, and the sooner your uncle sells out the better."

"But would it be right," said Rose earnestly, "to sell our shares at a high profit if things be as you say?"

"Quite right," replied Clearemout, with a bland smile of honesty; "*I* believe the mine to be a bad speculation; my friend, we shall suppose, believes it to be a good one. Believing as I do, I choose to sell out; believing as he does, he chooses to buy in. The simplest thing in the world, Miss Ellis. Done every day with eyes open, I assure you, but it is not every day that a chance occurs so opportunely as the present, and I felt it to be a duty to give my friend the benefit of my knowledge before quitting this place—for ever!"

There was something so kind and touching in the tone of the managing director that Rose was quite drawn towards him, and felt as if she had actually done him an unkindness in refusing him.

"But," continued her companion, "I can do nothing, Miss Ellis, without your assistance."

"You shall have it," said Rose earnestly; "for I would do anything that a woman might venture, to benefit my dear, dear uncle, and I feel assured that you would not ask me to do anything wrong or unwomanly."

"I would not indeed," answered Clearemout with emotion; "but the world is apt to misjudge in matters of delicacy. To ask you to meet me on the cliffs near Priest's Cove, close to Cape Cornwall, to-night, would appear wrong in the eyes of the world."

"And with justice," said Rose quickly, with a look of mingled dignity and surprise.

"Nevertheless, this is absolutely needful, if we would accomplish the object in view. A friend, whom I know to be desirous of purchasing shares in the mine is to pass round the Cape in his yacht this evening. The idea of offering these shares to him had not occurred to me when I wrote to say that I would meet him there. He cannot come up here, I know, but the stroke of a pen, with one of the family to witness it, will be sufficient."

It was a bold stroke of fancy in the managing director to put the matter in such a ridiculously unbusiness-like light, but he counted much on Rose's ignorance. As for poor Rose herself, she knew not what to say or do at first, but when Clearemout heaved a sigh, and, with an expression of deep sadness on his countenance, rose to take leave, she allowed a generous impulse to sway her.

"Your answer, then, is—No," said Clearemout, with deep pathos in his tone.

Now, it chanced that at this critical point in the conversation, Oliver Trembath, having left the cottage, walked over the grass towards a small gate near which the bower stood. He unavoidably heard the question, and also the quick, earnest reply—

"My answer, Mr. Clearemout, is, Yes. I will meet you this evening on the cliff."

She frankly gave him her hand as she spoke, and he gallantly pressed it to his lips, an act which took Rose by surprise, and caused her to pull it away suddenly. She then turned and ran out at one side of the bower to seek the solitude of her own apartment, while Clearemout left it by the other side, and stood face to face with the spell-bound Oliver.

To say that both gentlemen turned pale as their eyes met would not give an adequate idea of their appearance. Oliver's heart, as well as his body, when he heard the question and reply, stood still as if he had been paralysed. This then, he thought, was the end of all his hopes—hopes hardly admitted to himself, and never revealed to Rose, except in unstudied looks and tones. For a few moments his face grew absolutely livid, while he glared at his rival

On the other hand, Mr. Clearemout, believing that the whole of his conversation had been overheard, supposed that he had discovered all his villany to one who was thoroughly able, as well as willing, to thwart him. For a moment he felt an almost irresistible impulse to spring on and slay his enemy; his face became dark with suppressed emotion, and it is quite possible that in the fury of his disappointed malice he might have attempted violence, had not Oliver spoken. His voice was husky as he said—

"Chance, sir—unfortunate, miserable chance—led me to overhear the last few words that passed between you and—"

He paused, unable to say more. Instantly the truth flashed across Clearemout's quick mind. He drew himself up boldly, and the blood returned to his face as he replied—

"If so, sir, you cannot but be aware that the lady's choice is free, and that your aspect and attitude towards me are unworthy of a gentleman."

A wonderful influence for weal or woe ofttimes results from the selection of a phrase or a word. Had Clearemout charged Oliver with insolence or presumption, he would certainly have struck him to the ground; but the words "unworthy of a gentleman," created a revulsion in his feelings. Thought is swifter than light. He saw himself in the position of a disappointed man scowling on a successful rival who had done him no injury.

"Thank you, Clearemout. Your rebuke is merited," he said bitterly; and, turning on his heel, he bounded over the low stone wall of the garden, and hastened away.

Whither he went he knew not. A fierce fire seemed to rage in his breast and burn in his brain. At first he walked at full speed, but as he cleared the town he ran—ran as he had never run before. For the time being he was absolutely mad. Over marsh and moor he sped, clearing all obstacles with a bound, and making straight for the Land's End, with no definite purpose in view, for, after a time, he appeared to change his intention, if he had any. He turned sharp to the left, and ran straight to Penzance, never pausing in his mad career until he neared the town. The few labourers he chanced to pass on the way gazed after him in surprise, but he heeded not. At the cottage on the moor, where he had bandaged the shoulder of the little boy, a woman's voice called loudly, anxiously after him, but he paid no attention. At last he came to a full stop, and, pressing both hands tightly over his forehead, made a terrible effort to collect his thoughts. He was partially successful, and, with somewhat of his wonted composure, walked rapidly into the town.

CHAPTER XXXI.

DESCRIBES A MARRED PLOT, AND TELLS OF RETRIBUTIVE JUSTICE.

MEANWHILE the gossiping woman of the cottage on the moor, whose grateful heart had never forgotten the little kindness done to her boy by the young doctor, and who knew that the doctor loved Rose Ellis more surely, perhaps, than Rose did herself, went off in a state of deep anxiety to St. Just, and, by dint of diligent inquiries and piecing of things together, coupled with her knowledge of Clearemout's intentions, came to a pretty correct conclusion as to the state of affairs.

She then went to the abode of young Charles Tregarthen, whom she knew to be Oliver's friend, and unbosomed herself. Charlie repaid her with more than thanks, and almost hugged her in his gratitude for her prompt activity.

"And now, Mrs. Hicks," said he, "you shall see how we will thwart this scoundrel. As for Oliver Trembath, I cannot imagine what could take him into Penzance in the wild state that you describe. Of course this affair has to do with it, and he evidently has learned something of this, and must have misunderstood the matter, else assuredly he had not been absent at such a time. But why go to Penzance? However, he will clear up the mystery ere long, no doubt. Meanwhile we shall proceed to thwart your schemes, good Mr. Clearemout!"

So saying, Charlie Tregarthen set about laying his counter-plans. He also, as the managing director had done, visited several men, some of whom were miners and some smugglers, and arranged a meeting that evening near Cape Cornwall.

When evening drew on apace, four separate parties converged towards Priest's Cove. First, a boat crept along shore propelled by four men and steered by Jim Cuttance. Secondly, six stout men crept stealthily down to the Cove, led by Charles Tregarthen, with Maggot as his second in command. Thirdly, Rose Ellis wended her way to the rendezvous with trembling step and beating heart; and, fourthly, George Augustus Clearemout moved in the same direction.

But the managing director moved faster than the others, having a longer way to travel, for, having had to pay a last visit to Wheal Dooem, he rode thence to St. Just. On the way he was particularly interested in a water-wheel which worked a pump, beside which a man in mining costume was seated smoking his pipe.

"Good evening," said Clearemout, reining up.

"Good hevenin', sur."

"What does that pump?" asked the managing director, pointing to the wheel.

"That, sur?" said the miner, drawing a few whiffs from his pipe, "why, that do pump gold out o' the Londoners, that do."

The managing director chuckled very much, and said "Indeed!"

"Iss, sur," continued the miner, pointing to Wheal Dooem, "an' that wan theere, up over hill, do the same thing."

The managing director chuckled much more at this, and displayed his teeth largely as he nodded to the man and rode on.

Before his arrival at the rendezvous, the boat was run ashore not far from the spot where Tregarthen and his men were concealed. As soon as the men had landed, Charlie walked down to them alone and accosted their leader.

"Well, Cuttance, you're a pretty fellow to put your finger in such a dirty pie as this."

Cuttance had seen the approach of Tregarthen with surprise and some alarm.

"Well, sur," said he, without any of the bold expression that usually characterized him, "what can a man do when he's to be well paid for the job? I do confess that I don't half like it, but, after all, what have we got to do weth the opinions of owld aunts or uncles? If a gurl do choose to go off wi' the man she likes, that 's no matter to we, an' if I be well paid for lendin' a hand, why shouldn't I? But it do puzzle me, Mr. Tregarthen, to guess how you did come to knaw of it."

"That don't signify," said Tregarthen sternly. "Do you know who the girl is?"

"I don't knaw, an' I don't care," said Jim doggedly.

"What would you say if I told you it was Miss Rose Ellis?" said Charlie.

"I 'd say thee was a liard," replied Cuttance.

"Then I do tell you so."

"Thee don't mean that!" exclaimed the smuggler, with a blaze of amazement and wrath in his face.

"Indeed I do."

"Whew!" whistled Jim, "then that do explain the reason why that smooth-tongued feller said he would car' her to the boat close veiled up for fear the men should see her."

A rapid consultation was now held by the two as to the proper mode of proceeding. Cuttance counselled an immediate capture of the culprit, and pitching him off the end of Cape Cornwall, but Tregarthen advised that they should wait until Clearemout seized his victim, otherwise they could not convict him, because he would deny any intention of evil against Rose, and pretend that some other girl, who had been scared away by their impetuosity, was concerned, for they might depend on it he'd get up a plausible story and defeat them.

Tregarthen's plan was finally agreed to, and he returned to his men and explained matters.

Soon afterwards the managing director appeared coming down the road.

"Is all right?" he inquired of Cuttance, who went forward to meet him.

"All right, sur."

"Go down to the boat then and wait," he said, turning away.

Ere long he was joined by Rose, with whom he entered into conversation, leading her over the cape so as to get out of sight of the men, but young Tregarthen crept among the rocks and never for a moment lost sight of them. He saw Clearemout suddenly place a kerchief on Rose's mouth, and, despite the poor girl's struggles, tie it firmly so as to prevent her screaming, then he threw a large shawl over her, and catching her in his arms bore her swiftly towards the boat.

Tregarthen sprang up and confronted him.

Clearemout, astonished and maddened by this unexpected interference, shouted—

"Stand aside, sir! *You* have no interest in this matter, or right to interfere."

Charlie made no reply, but sprang on him like a tiger. Clearemout dropped his burden and grappled with the youth, who threw him in an instant, big though he was, for Tregarthen was a practised wrestler, and the managing director was not. His great strength, however, enabled him to get on his knees, and there is no saying how the struggle might have terminated had not Cuttance come forward, and, putting his hard hands round Clearêmout's throat, caused that gentleman's face to grow black, and his tongue and eyes to protrude. Having thus induced him to submit, he eased off the necklace, and assisted him to rise, while the men of both parties crowded round.

"Now, then, boys," cried Jim Cuttance, "bear a hand, one and all, and into the say with him."

The managing director was at once knocked off his legs, and borne shoulder high down to the beach by as many hands as could lay hold of him. Here they paused :—

"All together, boys– one—two—*ho !*"

At the word the unfortunate man was shot, by strong and willing arms, into the air, like a bombshell, and fell into the water with a splash that was not unlike an explosion.

Clearemout was a good swimmer. When he came to the surface he raised himself, and, clearing the water from his eyes, glanced round. Even in that extremity the quickness and self-possession of the man did not forsake him. He perceived at a glance, that the boat which, in the excitement of the capture, had been left by all the men, had floated off with the receding tide, and now lay a short distance from the shore.

At once he struck out for it. There was a shout of consternation and a rush to the water's edge. Maggot shot far ahead of the others, plunged into the sea and swam off. Observing this, and knowing well the courage and daring of the man, the rest stopped on the shore to witness the result.

Clearemont reached the boat first, but, owing to exhaustion, was unable to raise himself into it. Maggot soon came up and grasped him by the throat, both men managed to get their arms over the gunwale, but in their struggle upset the boat and were separated. Clearemont then made for the shore with the intention of giving himself up, and Maggot followed, but he was not equal in swimming to the managing director, whose long steady strokes easily took him beyond the reach of his pursuer. He reached the shore, and stalked slowly out of the water. At the same moment Maggot sank and disappeared.

The consternation of his comrades was so great that in the confusion their prisoner was unheeded. Some sprang into the sea and dived after him: others swam to the boat, intending to right it and get the boat-hooks.

Suddenly those who had remained on the beach observed something creep out of the sea near to some rocks a little to the right of the place where they stood. They ran towards it.

"Hallo! is that you, old Maggot?" they cried.

It was indeed the valiant smith himself! How he got there no one ever knew, nor could himself tell. It was conjectured that he must have become partially exhausted, and, after sinking, had crept along the bottom to the shore! However, be that as it may, there he was, lying with his arm lovingly round a rock, and the first thing he said on looking up was—

"Aw! my dear men, has any of 'ee got a chaw of baccy about 'ee?"

This was of course received with a shout of laughter, and unlimited offers of quids while they assisted him to rise.

Meanwhile Tregarthen was attending to Rose, who had swooned when Clearemont dropt her. He also kept a watch over the prisoner, who, however, showed no intention of attempting to escape, but sat on a stone with his face buried in his hands.

The men soon turned their attention to him again, and some of the more violent were advancing to seize him, with many terrible threats of further vengeance, when Rose ran between them, and entreated them to spare him.

Tregarthen seconded the proposal, and urged that as he had got pretty severe punishment already, they should set him free. This being agreed to, Charlie turned to the managing director, and said, with a look of pity, "You may go, sir, but, be assured, it is not for your own sake that we let you off. You know pretty well what the result would be if we chose to deliver you up to justice; we care more, however, for the feelings of this lady,—whose name would be unavoidably and disagreeably brought before the public at the trial—than we care for your getting your merited reward. But, mark me, if you ever open your lips on the subject, you shall not escape us."

"Iss," added Jim Cuttance, "an' remember, you chucklehead, that if you do write or utter wan word 'bout it, after gettin' back to London, there are here twelve Cornish men who will never rest till they have flayed thee alive!"

"You need have no fear," said Clearemout with a bitter smile, as he turned and walked away, followed by a groan from the whole party.

"Now, lads," said Cuttance after he was gone, "not wan word of this must ever be breathed, and we'll howld 'ee responsible, David Hicks, for t' wife's tongue; dost a hear?"

This was agreed to by all, and, to the credit of these honest smugglers, and of Mrs. Hicks, be it said, that not a syllable about the incident was ever heard of in the parish of St. Just from that day to this!

CHAPTER XXXII.

TOUCHES ON LOVE AND PILCHARD-FISHING.

THERE can be no doubt that "Fortune favours the brave," and Maggot was one of those braves whom, about this time, she took special delight in favouring.

Wild and apparently reckless though he was, Maggot had long cherished an ambitious hope, and had for some time past been laying by money for the purpose of accomplishing his object, which was the procuring of a seine-net and boats for the pilchard fishery. The recent successes he had met with in Botallack enabled him to achieve his aim more rapidly than he had anticipated, and, on the day following that in which Clearemout received his deserts, he went to Penberth Cove to see that all was in readiness; for pilchards had recently appeared off the coast in small shoals.

That same day Oliver Trembath, having spent a night of misery in Penzance, made up his mind to return to St. Just and face his fate like a man, but he found it so difficult to carry this resolve into effect that he diverged from the high-road—as he had done on his first memorable visit to that region,—and, without knowing very well why, sauntered in a very unenviable frame of mind towards Penberth Cove.

Old Mr. Donnithorne possessed a pretty villa near the cove, to which he was wont to migrate when Mrs. D. felt a desire for change of air, and in which he frequently entertained large parties of friends in the summer season. In his heart poor Mr. Donnithorne had condemned this villa "to the hammer," but the improved appearance of things in the mines had induced him to suspend the execution of the sentence. News of the appearance of pilchards, and a desire to give Rose a change after her late adventure, induced Mr. Donnithorne to hire a phaeton (he had recently parted with his own) and drive over to Penberth.

Arrived there, he sauntered down to the cove to look after his nets—for he dabbled in pilchard-fishing as well as in other matters—and Rose went off to have a quiet, solitary walk.

Thus it came to pass that she and Oliver Trembath suddenly met in a lonely part of the road between Penberth and Penzance. Ah those sudden and unexpected meetings! How pleasant they are, and how well every one who has had them remembers them!

"Miss Ellis!" exclaimed Oliver in surprise.

"Mr. Trembath!" exclaimed Rose in amazement.

You see, reader, how polite they were, but you can neither see nor conceive how great was the effort made by each to conceal the tumult that agitated the breast and flushed the countenance, while the tongue was thus ably controlled. It did not last long however. Oliver being thrown off his guard asked a number of confused questions, and Rose, in her somewhat irrelevant replies, happened to make some reference to "that villain Clearemont."

"Villain?" echoed Oliver in undisguised amazement.

"The villain," repeated Rose, with a flushed face and flashing eye.

"What? why! how?—really, excuse me, Miss Ellis—I—I—the villain—Clearemont—you don't—"

There is no saying how many more ridiculous exclamations Oliver might have made had not Rose suddenly said—

"Surely, Mr. Trembath, you have heard of his villany?"

"No, never; not a word. Pray do tell me, Miss Ellis."

Rose at once related the circumstances of her late adventure, with much indignation in her tone and many a blush on her brow.

Before she had half done, Oliver's powers of restraint gave way.

"Then you never loved him?" he exclaimed.

"Loved him, sir! I do not understand—"

"Forgive me, Rose; I mean—I didn't imagine—That is to say—oh! Rose, can it be—is it possible—my *dear* girl!—"

He seized her hand at this point, and—but really, reader, why should we go on? Is it not something like a violation of good taste to be too particular here? Is it not sufficient to say that old Mr. Donnithorne came suddenly, and of course unexpectedly, on them at that critical juncture, rendering it necessary for Rose to burst away and hide her blushing face on her uncle's shoulder, while Oliver, utterly overwhelmed, turned and walked (we won't say fled) at full speed in the direction of the cove.

Here he found things in a condition that was admirably suited to the state of his feelings. The fishermen of the cove were in a state of wild excitement, for an enormous shoal of pilchards had been enclosed in the seine-nets, and Maggot with his men, as well as the people employed by Mr. Donnithorne, were as much over head and ears in fishing as Oliver was in love. Do you ask, "Why all this excitement?" We will tell you.

The pilchard-fishing is to the Cornish fisherman what the harvest is to the husbandman, but this harvest of the sea is not the result of prolonged labour, care, and wisdom. It comes to him in a night. It may last only a few days, or weeks. Sometimes it fails altogether. During these days of sunshine he must toil with unwonted energy. There is no rest for him while the season lasts if he would not miss his opportunity. The pilchard is a little fish resembling a small herring. It visits the southern coasts of England in autumn and winter, and the shoals are so enormous as to defy calculation or description. When they arrive on the coast, "huers"—sharp-sighted men—are stationed on the cliffs to direct the boatmen when to go out and where to shoot their seine-nets. When these are shot, millions of pilchards are often enclosed in a single net.

To give an idea of the numbers of fish, and extent of the fishing, in a few words, we may state the fact that, in 1834, one shoal of great depth, and nearly a mile broad, extended from Hayle River to St. Ives, a distance of two and a half miles. A seine was shot into this mass, and 3600 hogsheads were carried to the curing-cellars. As there are 3000 pilchards in each hogshead, the catch amounted to nearly eleven million fish! The value of these might be £3 a hogshead, and the clear profit about £1 a hogshead, so that it is no wonder we hear of fortunes having been made in a few hauls of the pilchard-seines. At the same time losses are sometimes very heavy, owing to gales arising and breaking or carrying away the nets. Such facts, combined with the uncertainty of the arrival or continuance of the fish on any particular part of the coast, tend to induce that spirit of eager, anxious excitement to which we have referred as being so congenial to Oliver Trembath's state of mind at the time of which we write.

On the beach the young doctor found Maggot and his men launching their boats, and of course he lent them a hand.

"Pilchards been seen?" he inquired.

"Iss, iss, doctor," was the smith's curt reply; "jump in, an' go 'long with us."

Oliver accepted the invitation, and was rowed towards a part of the bay where the sea appeared to be boiling. The boat was a large one, attended by several others of smaller dimensions. The boiling spot being reached, Maggot, whose whole being was in a blaze of enthusiasm, leaped up and seized the end of a seine-net—three hundred fathoms long by fourteen deep—which he began to throw overboard with the utmost energy, while the boat was rowed swiftly round the mass of fish. David Trevarrow assisted him, and in less than four minutes the whole net was in the sea. One of the other boats, meanwhile, had fastened another net to the first, and, rowing in an opposite direction from it, progressed in a circular course, dropping its net as it went, until the two met—and thus an immense shoal of pilchards was enclosed.

The nets being floated on the surface with corks, and their lower ends sunk to the bottom with leads, the fish were thus securely imprisoned. But the security was not great; a gale might arise which would sweep away the whole concern, or the pilchards might take a fancy to make a dash in one particular direction, in the event of which they would certainly burst the net, and no human power could save a single fin. In order to prevent this, the men in the smaller boats rowed round the seine, beat the sea with their oars, hallooed, and otherwise exerted themselves to keep the fish in the centre of the enclosure. Meanwhile a little boat entered within the circle, having a small net, named a "tuck-net," which was spread round the seine, inside, and gradually drawn together, until the fish were raised towards the surface in a solid, weltering mass. The excitement at this point became tremendous. Thousands of silvery fish leaped, vaulted, and fluttered in a seething mass on the sea. Maggot roared and yelled his orders like a Stentor. Even mild David Trevarrow lost self-command, and shouted vociferously.

"Hand the basket," cried Maggot.

A large basket, with a rope attached to one handle, was produced. Maggot seized the other handle, and thrust it down among the wriggling pilchards. Trevarrow hauled on the rope, lifted the basket out of the sea, and a cataract of living silver was shot into the boat, accompanied by a mighty cheer. Basketful after basketful followed, until the men stood leg-deep in fish.

"Hold on a bit," cried Maggot, as, with rolled-up sleeves, dishevelled hair, and glaring eyes, he threw one leg over the side of the boat, the more easily to continue his work.

"Have a care," cried Oliver at that moment, stretching out his hand; but he was too late. The excitable smith had overbalanced himself, and was already head and shoulders deep down among the pilchards, which sprang high over him, as if in triumph!

To catch him by the legs, and pull him back into the boat, was the work of a moment, but the proceedings were not interrupted by the mishap. A laugh greeted the smith as he was turned head up, and immediately he braced himself to his arduous labour with renewed energy

The boat filled, it was rowed to the shore, and here was received by eager and noisy men, women, and children, by whom the precious contents were carried to the "cellars," or salting-houses, where they were packed in the neatest possible piles, layer by layer, heads and tails, with a sprinkling of salt between.

Maggot's family had followed him to Penberth. Mrs. M. was there, busy as a bee—so was Zackey, so was little Grace, and so was the baby. They all worked like Trojans, the only difference between baby Maggot and the others being, that, while they did as much work as in them lay, he undid as much as possible; was in every one's way; fell over and into everything, including the sea, and, generally, fulfilled his mission of mischief-maker with credit. The chet was there too! Baby Maggot had decreed that it should accompany him, so there it was, living on pilchards, and dragging out its harassed existence in the usual way. What between salt food, and play, kicks, cuffs, capers, and gluttony, its aspect at that time was more demoniacal, perhaps, than that of any other chet between John o' Groat's and the Land's End.

Volumes would scarcely contain all that might be written about this wonderful scene, but enough has been said to indicate the process whereby Maggot secured and salted some hundreds of thousands of pilchards. The enclosing of the fish was the result of a few minutes' work, but the salting and packing was not ended for many days. The result, however, was that the lucky smith sent many hogsheads of pilchards the way of most Cornish fish, namely, to the Mediterranean, for consumption by Roman Catholics, and in due course he received the proceeds, to the extent of three thousand pounds.

Thus did Maggot auspiciously begin the making of his fortune—which was originated and finally completed by his successful mining operations at Botallack.

And let it be observed here, that he was neither the first nor the last poor man who became prosperous and wealthy by similar means. There are men, not a few, now alive in Cornwall, who began with hammer and pick, and who now can afford to drink in champagne, out of a golden flagon, the good old Cornish toast—" Fish, tin, and copper."

CHAPTER XXXIII.

THE LAST.

MANY others as well as Maggot made money by the pilchards at that time. All round the coast of Cornwall millions of these little fish were taken, salted, and exported. No fewer than one thousand hogsheads were taken at St. Ives in the first three seine-nets cast into the sea. In Mounts Bay, Fowey Bay, Mevagissey, and other fishing grounds, immense quantities were caught, and the total catch of the county was little if at all short of thirty thousand hogsheads.

Among others, old Mr. Donnithorne was so successful, that his broken fortunes were almost re-established, and a small sum which our friend Oliver Trembath had ventured to invest in the fishing was more than quadrupled before the end of the year.

But this was not all. At the next Botallack account-dinner, Mr. Cornish gladdened the hearts of the adventurers by telling them that the lodes which had been "promising" for such a length of time had at last got the length of "performance," and that he had now the pleasure of announcing a large dividend—which he paid there and then.

A considerable share of this fell to old Mr. Donnithorne, who, in the enthusiasm of the occasion, observed confidentially to Captain Dan that he was convinced "honesty was the best policy after all"—a sentiment which the Captain heartily agreed with, although he failed to detect the precise connexion between it and the old gentleman's sudden influx of good fortune. But, then, the Captain did not drink Botallack punch, while old Mr. Donnithorne did, which may to some extent account for the difference in their powers of vision.

Captain Dan, however, possessed wonderful powers of vision in reference to the underground workings of Botallack, which were displayed to advantage—and to the great gratification of the shareholders,—when, at the request of Mr. Cornish, he stood up and gave a detailed and graphic account of the prospects of the mine; telling them that the appearance of the lodes in several parts of the mine was very promising indeed, and that some ground was returning a rich harvest for the labour that had been bestowed on it; that in the 105, which was driving north by six men, they had taken down the copper for fourteen fathoms long, nearly the whole of which had turned out to be worth £100 per fathom; that a splice had been formed in the lode about two fathoms behind the present end, which had disordered it, but he was glad to say it was again improving, and was at that time about fifteen inches wide of rich copper, and, as far as he could judge, they were going through to the top part of the *bunch* of copper; that these facts, he thought, were very satisfactory, but that it was still more gratifying to know that the lode on the bottom of the 105 was far more valuable than that in the back; that in the "*Crowns*," especially in the various levels under the sea, the lodes were not only "promising," but performing great things, two men and a boy (he referred to Maggot, Trevarrow, and Zackey here) having broken an immense quantity of copper during the last quarter, which was paying splendidly.

At this point, Mr. Grenfell, who sat on Mr. Cornish's right hand, exclaimed, "Hear! hear!" and a little bald-headed man, with a red nose and blue spectacles, near the foot of the table, echoed "Hear!" with genuine enthusiasm (for he had been bordering on bankruptcy for some months past), and swigged off a full glass of punch without winking.

Thus encouraged, Captain Dan went on to remark that there were six men driving in *Wheal Hazzard* (which statement caused a "stranger" who chanced to be at the dinner to observe, in an under tone, that he was not aware they had horses or vehicles of any kind in the mines !), that one cross-cut was also being driven, and three winzes were sinking, and one rise —several of which were opening up tin of first-rate quality, while in the *Narrow* shaft, *Chicornish*, *Higher Mine*, and *Wheal Cock* a great deal to the same effect was being done,—all of which we leave to the imagination of the reader, merely remarking that however incomprehensible these things may appear to him (or her), they created feelings of profound joy in the assembled guests, especially in the breast of the almost-bankrupt one with the bald, red, and blue head-piece.

Mr. Cornish afterwards congratulated the adventurers on the success of the mine, and the splendid prospects which were opening up to them—prospects which, he had no doubt, would be fully realized ere long. He referred also to the condition of the miners of the neighbourhood, and alluded to the fact that the neighbouring mines, Wheal Owles and Levant, were also in a flourishing condition; a matter, he said, for which they had reason to be profoundly thankful, for the distress in the district had been severe and prolonged. The manager's voice deepened at this point, and he spoke with pathos, for he had a kindly heart, and his thoughts were at the moment with many a poor miner, in whose little cottages the effects of gaunt poverty could be traced in scanty furniture, meagre fare, and careworn brows. He remembered, too, that only the week before he had seen poor blind John Batten carried to his grave, and had heard the sobs of the bereaved widow, as she attempted to tell him how the brave man had forgotten himself to the very last, when he put his wasted hand on her head, and said, "I'm goin' to leave thee, Mary, for a time, but cheer up, dear lass, I'll be with Jesus soon, an' have my sight restored, and look wance more 'pon the faces of the dear boys, an' 'pon your own sweet face, too, dear lass, when we meet again in heaven."

There was one of the miners, and shareholders, of Botallack who did not die, but who lived to enjoy the fruit of his labour and the sunshine of prosperity. James Penrose recovered—not only his health, but also, in some degree, his sight. One of his eyes had indeed been entirely destroyed by the explosion which had so nearly killed him, but the other was partially restored. A long period elapsed, however, ere he was able to go about. Then he found his circumstances so much improved, that it was not necessary to resume work underground. Botallack, in which all his savings had been invested, continued steadily to improve, and from the income derived from this source alone he was enabled to live without labouring. But Penrose was not the man to sit down in idleness. Wesley never had a more earnest follower than this miner of St. Just. Thenceforth he devoted himself to preaching, teaching, and doing good as his hand found opportunity, and, being an active man as well as conscientious, he laboured to the end of his days in the service of his Lord more energetically than he had ever toiled in the mines.

Penrose and David Trevarrow had always been stanch friends. After the accident to the former, they became more closely united than before. Trevarrow did not give up underground work ; he possessed no shares in any of the mines, but, in common with the rest of the mining community, he benefited by the sunshine of prosperity that became so bright at that period, and found leisure, when above ground, to join his friend in his labours of love.

They both agreed to make an earnest effort to convince Maggot and John Cock of the error of their ways—with what amount of success it is not easy to state, for these worthies were made of stubborn metal, that required a furnace of unusually fierce heat to melt it ! However, we are warranted in concluding that some good was done, from the fact that both of them gave up smuggling, and, in various other ways, showed indication of an improved state of mind. Maggot especially gave a signal and unexpected proof of a softened spirit, when, one Sunday morning, as he was getting ready for chapel, he said to his wife that it was "high time to send that little chucklehead the baby to Sunday-school, for he was no better than a small heathen!" The "baby," be it observed, was about six years old at the time when this speech was made, and his *protégé* the "chet" was a great-grandmother, with innumerable chets of her own. It is right to add that, in accordance with this opinion of his father, the baby was carried off to school that very morning by Zackey and Grace, the first having grown to be a strapping youth, and the other a lovely girl, for whose sake there were scores of young miners in St. Just who would gladly have walked ten miles on their bare knees, or dived head-foremost into Wheal Hazzard shaft, or jumped over the cliffs into Zawn-buzz-an-gein, or done any other insane act or desperate deed, if, by so doing, they could have caused one thrill of pleasure to pass through her dear little heart!

It is not necessary, we should think, to say that in the midst of so much sunshine Oliver Trembath and Rose Ellis thought it advisable to "make hay." Old Mr. Donnithorne and his excellent wife (of whose goodness and wisdom, by the way, he became more and more convinced every day of his life) saw no objection whatever to this hay-making—so the young couple were wed at the Wesleyan Chapel of St. Just—Charlie Tregarthen, of course, being groomsman,—and the only vehicle in the town was hired to drive them over to Penberth Cove and bliss!

As to George Augustus Clearemout, Esq.—that able managing-director, despite his ducking at St. Just, continued to fill his chair and to fulfil his destiny in the airy little street in London, where, for many years, he represented Wheal Dooem, and "did" a too confiding public. In this work he was ably assisted by Secretary Jack Muddle, who became quite celebrated as a clear expounder and explainer of veins, lodes, ores, cross-cuts, shafts, levels, winzes, minerals, metals, and mines—insomuch that he was regarded by many of the confiding public who frequented his office as a more thoroughly learned and scientific man than George Augustus himself. It is interesting, however, to have to record the curious fact that the too confiding public changed their opinion at last on this head, and came to regard Secretary Jack as a humbug, and the managing director as a scoundrel. Unfortunately this change of opinion did not take place until the whole of the too confiding public (the T. C. P., as Clearemout styled them) had lost large sums of money, and a few of them become bankrupt. When affairs had reached this crisis, one of the T. C. P.—an irascible old gentleman, whose fiery nature seemed to have singed all the hair off his head, leaving it completely bald—went down to Cornwall in a passion to sift the thing for himself. There he found the Great Wheal Dooem pump-engine going full swing, day and night, under the superintendence of one man, while the vast works underground (on which depended the "enormous" dividends promised to and expected by the T. C. P.) were carried on by another man and a boy. On making this discovery the fiery old gentleman with the denuded head left Cornwall—still in a passion—and exploded in the face of a meeting of the members of the T. C. P., who immediately exploded in each other's faces, and appointed an indignation committee to go and explode, with unexampled fury, in the faces of the managing director and Secretary Jack. But these knowing gentlemen, being aware that the explosion was coming, had wisely betaken themselves to the retirement and seclusion of the Continent.

Without troubling the reader with further particulars, we may say, in conclusion, that the result was the stoppage of Wheal Dooem mining operations, and the summary dismissal of the two men and the boy. At the present day the ruins of that great concern may be seen standing on the wild sea-cliffs of west Cornwall, solitary, gaunt, and grey, with the iron "bob" of the pump-engine motionless and pointing up obliquely to the sky, as if the giant arm of the mine were upraised to protest for ever against the villany and the too confiding folly that had left it standing there,—a monument of wasted and misdirected energy—a caution to all speculators —a deserted mine—in the language of miners, a "knacked bal."

There are many such "knacked bals" in Cornwall, with their iron "bobs,"—horizontal, depressed, or raised aloft, according to the attitude in which they expired—holding forth similar firm, silent, and perpetual protests and cautions. Many Wheal Dooems (which having accomplished their ends may now be termed Wheal Donems) are to be seen all over the country on gorse-clad hills and on bold headlands; but, alongside of these, may be seen their venerable ancestors, still alive and working; subject, indeed, at times, to fits of depression, when, as their indomitable and unconquerable managers will tell you, "the price of tin is low," and subject also to seasons of revival, when they are getting a "little better price for tin," but still working on with untiring persistency whether the price of tin be high or low.

Chief among these, our chosen type, Botallack, may be seen bristling on the grey cliffs of the "far west" with the Atlantic winds and spray revelling amongst its machinery, and the thunder of its stamps giving constant token that hundreds of stout-hearted, strong-limbed Cornishmen are still hewing out tin and copper from its gloomy depths, as they did in days gone by, and as they will, doubtless, continue to do in time to come—steadily, sternly, manfully doing their work of sinking and extending the mine deeper down under the sod and further out under the sea.

THE END.